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SCHOOL SCIENCE AND MATHEMATICS

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THE ELECTRON MICROSCOPE

One of the most interesting lectures delivered at the November meeting of the Central Association of Science and Mathematics Teachers was that of Dr. James Hillier of the Research Laboratories of the Radio Corporation of America. Dr. Hillier is only twenty-six years of age but shares with Dr. Vladimir Zworkin and Dr. Arthur Vance the honor of developing the electron microscope.

The electron microscope is one of the really great instruments of all time. An ordinary microscope focuses a beam of light rays by using glass lenses. It enables the eye to see objects 2000 angstroms in diameter. If quartz lenses, ultraviolet light, and a photographic film are used, objects as small as 800 angstroms in diameter may be observed. The electron microscope, using a beam of electrons, focusing it by means of magnetic and electrostatic fields, and catching the image on a fluorescent screen where it may be seen or photographed, brings into view objects only a few angstroms in diameter. The electron microscope is from fifty to one hundred times as powerful as the best light beam microscope. This new tool of science is so powerful that it enables an entomologist to examine the minute organs of insects with the ease of a tree surgeon looking over a new "patient."

Dr. Hillier's lecture was illustrated by many electron micrographs, as the photos taken directly on the electron microscope are known. Tobacco mosaic virus, typhoid and tuberculosis germs were shown, and a grain of finest face powder magnified until it resembled a piece of shrapnel.

One of Dr. Hillier's most interesting exhibits was an electron micrograph of the windpipe of a mosquito, which showed it en-

larged to the dimensions of a tree trunk. The picture is so sharp that tiny hoops lining and reinforcing the sheer walls of the windpipe are shown to be covered with tiny sub-microscopic spines. The hoops are only one fifty-thousandth of an inch broad, and the small spines are less than one quarter-millionth of an inch in length. In the micrograph the hoops appear as heavy wire ribs.

The electron micrographs of the mosquito windpipe and other interesting pictures of insect structures were made by Dr. A. Glenn Richards, Jr., Entomologist of the University of Pennsylvania, at the RCA Laboratories in collaboration with Dr. Thomas F. Anderson, RCA Fellow of the National Research Council.

In the RCA Laboratories, studies are being made through the powerful eye of the electron microscope to reveal for the first time the intricate construction of the skin, hair and wings of butterflies, bees, cockroaches, flies, beetles and even the submicroscopic details of their egg shells.

Industrially, the instrument is being used in national defense in a number of important research laboratories and has been installed in the United States Bureau of Standards.

IRON IN ALASKA

Deposits of iron ore on the Kasaan Peninsula in southeastern Alaska have been confirmed as extensive and high grade by the Geological Survey, United States Department of the Interior.

First appraised in 1917 during the World War as possible sources of iron, the deposits now are believed to be much larger than the earlier estimates of minimum reserves of 10,000,000 tons.

Field examinations of more than a dozen of the ore bodies, classified as magnetite, indicate that the iron content may approach 60 per cent. Although no adequate specific determinations have been made of the tenor and impurities in the iron ores of Kasaan Peninsula, the copper content is estimated at about 0.5 per cent, and the sulfur content may be about 1.5 per cent.

Many of the individual bodies of high-grade magnetic probably contain between 25,000 and 2,000,000 tons each, and some of the bodies may contain even more than 2,000,000 tons, it was reported by the Geological Survey. These substantial deposits, if their grade holds with depth, may have national significance in connection with the large hydroelectric installations at the Grand Coulee and Bonneville power projects. The availability of large quantities of cheap electric power in the Pacific Northwest area, coupled with the needs for iron and steel of the Nation's war machine, focuses attention of expanding industrialization not only on the Kasaan deposits, but also on similar deposits on Texada and Vancouver Islands, British Columbia, and in the vicinity of Copper Mountain, Prince of Wales Island, Alaska.

THE ARTIFICIAL CREATION OF SPEECH

DR. J. OWEN PERRINE
American Telephone and Telegraph Company

[This article is a description of a demonstration-lecture given by Dr. J. Owen Perrine, of the American Telephone and Telegraph Company, assisted by Miss Swenson, Voder Operator, and Engineering Assistant Mr. Richey. This discussion of the character of speech sounds, their analysis and synthesis, and the electrical means for creating speech-like sounds was delivered before a large audience at the annual banquet of the Central Association of Science and Mathematics Teachers at the Stevens Hotel, Chicago, November 21, 1941.—EDITOR.]

To make the sounds constituting human speech by mechanical processes has been a field of investigation for scientists and voice specialists for over a century. To produce elemental sounds artificially and to combine them into words as the human vocal cords and mouth do naturally, has not been an easy task. Human speech requires skillfully coordinated motions of lips, jaws, vocal cords and tongue. In the past the attempts to imitate human speech involved purely mechanical means—vibrating reeds, tuning forks and organ pipes. The artificial creation of basic sounds and the phrasing of these sounds into words and connected speech have finally been accomplished by electrical apparatus and techniques.

With the application of Bell's invention of the telephone, however, a great deal of knowledge has come from the alliance of electrical apparatus and human speech. The ramifications of this alliance, first embodied in the telephone, are manifold today.

The discovery of recent facts about speech, resulting from telephone research, and the development of distinctively electrical apparatus in contrast to purely mechanical apparatus for making sounds that emanate finally from a loud speaker, have made it possible for the first time in the history of electrical and acoustical science to design electrical apparatus which very successfully produces speech sounding human.

THE "VODER" EQUIPMENT

Essentially the apparatus, sometimes called the "Voder" (voice operation demonstrator), is an electrical arrangement which corresponds to the human speech mechanism in its production of speech and in the completeness of control thereof. It was designed in the Bell Telephone Laboratories, and is built

entirely, except for its keys, of apparatus used in everyday telephone service.

The transportable "Voder" equipment is arranged in four separate physical sections. First is the control board or "console." The two vacuum tube audio frequency generators which produce the electric currents which later become the two basic sounds out of the loud speakers are the second part. "Regular" and "emergency" generators are mounted on panels in a cabinet.

"Regular" and "emergency" amplifiers, together with public address microphone and music input controls, are mounted in another cabinet as the third section. Three "750" loud speakers, the latest in high fidelity loud speakers of Bell System design and manufacture, comprise the fourth section. These three speakers are pointed in different directions so as to adequately "cover" the audience for both the Voder output, the speaker's voice and music. The four sections are arranged along the front of the platform and are interconnected by shielded cables.

It is played by a girl operator from a console which resembles a little old-fashioned organ with a small keyboard and pedal. The operation of the keys and pedal in accordance with a definite system enables speech to be synthesized. Quite an array of electrical equipment, including amplifiers and loud speakers, comprises the necessary working elements of the "Voder" ensemble.

How the "Voder" Works

In human speech there are two kinds of sound, and the synthesizer has electrical equipment corresponding to each of these. One kind of sound is made by forcing the breath through the mouth, past the tongue, teeth and lips, while shaping the mouth cavity. This is the way in which are made the unvoiced consonant sounds like "s" and "h." This is the way in which are made all of the sounds of speech when one whispers. In the synthesizer there is an electrical source which supplies a steady sound stream resembling a radiator sizzle for shaping into such sounds. By pressing the proper combination of keys the operator shapes the sound stream into the proper electrical current for making any of these sounds issue from the loud speaker.

The other kind of sound which enters into human speech comes from the vocal cords. The most important of these sounds are the vowels like "a," "o" and "u." The human vocal cords give off a very complex and somewhat musical sound. When

one talks he shapes his mouth cavity so that some particular parts of this complex sound come through clearly, while other parts are suppressed in varying degree. In the synthesizer there is an electrical source of sound corresponding to the vocal cords. There is provided a pedal for changing the pitch, thus giving to speech a rising or falling inflection as desired.

Analogy of Color

Just as a painter with different color pigments combines them on his palette to make a resultant tint or intermediate color for his picture, so the various keys facilely permit rapid combinations of tone to make the various vowels, consonants and words. There have been fine light arrangements, called "color" organs, which play different colored lights on a screen to produce changing patterns of resultant colors. In somewhat similar but in a more positive fashion to produce something real, namely speech sounds, the "voder" ensemble is a tone organ resulting in actual words and sentences.

Demonstration Features

In his talk Dr. Perrine discussed speech sounds and their basic elements. Miss Swenson at the console performed some very interesting speech demonstrations to illustrate the points made by Dr. Perrine. He showed that after various sounds have been studied their re-creation by proper combinations of acoustic frequencies becomes an easier task.

The girl operator in reality plays the role of an analyzer, in fact an acoustical, physiological, mechanical analyzer. A great deal of training and talent are required to enable the girl operator to play the role of such an analyzer. In this role, then, she uses her fingers, wrist and foot to control electrical circuits which in turn control the electrical frequency generating systems of the synthesizer which finally actuates the loud speaker. As an analyzer the girl operator can call on the synthesizer to create speech sounds.

In addition to showing the elemental sounds and individual features of the apparatus, Miss Swenson enunciated the letters of the alphabet, the numbers from one to ten, *Mary Had a Little Lamb*, and various interesting multiple syllable words. She amused the audience by making the "voder" ensemble introduce officials seated at the Speaker's table, and startled everyone by producing a very basso profundo voice, a high pitched

treble, the shaky voice of an old man, and a hearty laugh.The climax came when Mr. McGrath of the Western Electric Company of Chicago and "Pedro, the Voder" sang together *At Home on the Range* and other popular numbers.

Practical Use of the "Voder"

It is hoped that out of studies of this kind and further developments, instrumentalities and facilities may be provided for carrying more telephone conversations over existing lines without interference of one with any other.

From the point of view of electrical transmission of speech, the synthesizer principle and mechanism are basically tantamount to sending speech sounds by telegraphic means, that is, telephone messages by what might be thought of as telegraphic signals in that they intrinsically bear no speech but are code signals to actuate synthesizing equipment at the distant point.

The lecture touched also on the significance of the "voder" as a step in serious telephone research. With the means of artificially creating speech at hand, one may speculate on the possibility of doing so at a distant point. Is it possible that some day the words spoken into a telephone may be converted into narrow bands of frequency simulating telegraph signals which, in turn, at the distant end of the line, will control electrical currents to re-create the words of the speaker? That question cannot be answered now. But, since telegraph signals may be transmitted over a much narrower band of frequencies than is required for direct voice transmission, such sending of telephone messages by telegraphic means would make possible the multiplication of speech channels over telephone lines by methods different from the present highly acceptable carrier systems.

This electrical apparatus, which does create speech sounds quite well, is the first of its kind in the world, after many splendid attempts dating back to 1780 to do the same by mechanical means.

These mechanical means of yesteryear were not flexible, were not versatile. The human mechanisms of vocal cords, lungs, throat, mouth and nasal cavities are an amazing array of flexible and versatile elements. The electrical apparatus of the "voder" approximates in some degree the flexibility and versatility of the human voice apparatus.

To be sure, the "voder" is directed by the dexterous fingers and foot of a versatile and talented young woman.

TRENDS IN TEACHING MATHEMATICS*

MARY A. POTTER
Supervisor of Mathematics, Racine, Wisconsin

To discuss the trends of teaching any subject, be it mathematics or science, or even social science, it is necessary to examine the trends of the social and economic world in which this teaching has taken place.

Once upon a time these social and economic changes moved with a slow motion pace; they are now taking place with the speed of light. In the horse and buggy days the battle of New Orleans was fought more than two weeks after the treaty of peace had terminated the war of which that battle was a part. In these days of radio and airplane, we hear accurate reports of battles in Europe as soon—and sometimes before—they are fought, a paradox made possible by the difference in time.

Educational practice has always lagged notoriously behind world changes, which is usually a grave fault but occasionally becomes an excellent, conservative brake on the mad rush of modern change. In a democracy it is impossible for education to proceed faster than public opinion dictates.

May I recall briefly the changes shown by Mr. John Q. Public in his attitude toward mathematics in the past twenty-five years?

In the beginning of this era, high school mathematics was an accepted part of the secondary school curriculum taken as a matter of course by most students, but a subject whose value some educators were beginning to question. In general it was very abstract, and endured rather than adored.

At the time of World War I, mathematics was elevated to a somewhat higher position. Fighting had become more mechanical; war machines were invented, built, and operated by science which in turn was ruled by mathematics. Many people recognized the power of this invisible monarch, and insisted that their children be trained in the ways of mathematics.

But John Q. Public is fickle. He was dazzled by the easy living of the late twenties; he coveted for his offspring the soft life which he now was enjoying himself. He would bring up his son to be a bond salesman. Then why should his darling children be

* Read at the Annual Convention of the Central Association of Science and Mathematics Teachers at Chicago, Nov. 21, 1941.

subjected to the rigors imposed by difficult problems in algebra, or theorems in geometry; perhaps even some arithmetic was not necessary and, he reasoned, it certainly was taught when the children were far too young.

Then came the crash, and Mr. Public, like Chicken Little, wondered why the sky fell on his head. He decided economics could give him the answer. Economics and its sister branches of social science became the royal family to which every other subject was subservient and many attempts were made to eject mathematics from the house of learning. Mr. Public could read in the press such items as this, which appeared in a midwestern paper:

Suggest Table Tennis in Place of Algebra

"Proposals that table tennis replace algebra and that photography replace English in high school curricula were advanced by students of three suburban high schools in a forum here.

"Jean Bloom of Monroe, Michigan, suggested also that dancing be substituted for Latin, and dramatics for history.

" 'If our present teachers cannot teach those subjects, they should go to summer school and learn how,' she added."

Although the darkest clouds of financial worry were gradually being dispersed, the depression continued, only to be terminated by World War II.

This new war is a ruthless conflict in which highly complicated mechanized weapons can wipe out nations of brave but unarmed people. Building and using these new military machines requires a degree of mathematical and technical proficiency never before required by industry and the military forces.

John Q. Public continues to read the papers and listen to the radio. He hears of excellent jobs waiting for the skilled mechanic, who must be versed in high school mathematics. He sees the fat pay envelopes of neighbor Smith, who is a carefully trained tool and die maker, and of neighbor Jones, an expert machinist.

He reads that his son Johnny is offered a free education by the government if he is proficient in high school mathematics.

One paper tells him: "An ounce of calculus is worth a pound of courage."

Again he reads: "There can be a bottleneck in mathematics just as surely as in machine tools."

He ponders over these headlines appearing in the *New York Times:*

"Mathematics Held Important; Proposal to Substitute History Units Regarded as Impractical."

"Physicists Needed; Shortage Laid to Failure to Major in Mathematics."

"Says Mathematics Opens Jobs to Girls; Calculations Work Offers Niche in Defense, General Electric Expert Avers."

Should Mr. Public now advise his younger son, Jim, to take mathematics? And as he looks at the large number of women working in the factories, he wonders if Mary Lou might not profit by studying this algebra and geometry and maybe trigonometry, whatever-that-is.

Convinced that the education they thought perfect in the 1930's is not suitable for the 1940's, Mr. and Mrs. John Q. Public hold a family conference and decide that Mrs. Public should visit schools, which they have never done. They hope to find out what is happening now, and what advice they should give to their younger children.

Mrs. Public first visited the second grade in which their daughter Sally was enrolled. From the joy of the children in their work, the amusing games they played, from their beautifully illustrated and interesting textbooks, and the many objects and colorful pictures they used as they learned their number combinations, Mrs. Public could hardly believe she was visiting school, but fancied she was observing a gay, well-organized children's party. After the class she visited with the principal, Mr. Blank.

"Yes, Mrs. Public, the children do enjoy their arithmetic," he said. "You see in the last ten years we have been learning how to teach it better. First we thought the children began to study it when they were too young, but we found that many of the same difficulties arose no matter how old they were when we began the instruction. If we postponed teaching arithmetic too long, the better students began to bootleg arithmetic which created new problems. It is best to begin teaching any subject when children want to use it outside of school.

"We found our chief trouble was that children could recite (and forget) facts like parrots without knowing what they were doing. We now try to teach the meaning of numbers and of processes, first with concrete objects and, arrive at the abstract facts. We try to relate all of our arithmetic work to the experiences the child has outside of school.

"Do we drill? Of course it is necessary, but the drill is now full of meaning to the children instead of the nonsense syllables they once repeated.

"Another important change comes in the way we teach a topic in a number of grades. For instance, fractions used to be begun and completed in the fifth grade, and teachers in all the upper grades complained about the lack of skill acquired there. All of the newer text books that I have seen introduce different parts of the work with fractions in several grades. This gives the children time to digest these radically new ideas, and our results are much better."

When she visited the junior and senior high schools, Mrs. Public found that the elementary school principal had given her merely the introduction to change in grade placement of subject matter.

"Oh, yes," said Miss Friend, the eight grade teacher, "we teach arithmetic in the upper grades. We need to review the work they learned in the elementary school and teach percentage. Unless children know arithmetic thoroughly, they find any other work in mathematics very difficult. But the hard topics of arithmetic are almost impossible for children to understand until they are older.

"We are all convinced that a thorough teaching of topics like insurance should be postponed until the children have become mature enough outside of school to understand what they are being taught in school. So we have a course featuring economic mathematics in the twelfth grade.

"When I went to school, Mrs. Public, I learned graphing and scale drawing in my first year at college. Now very easy graphing and scale drawing are begun in the fifth grade in our city, and are taught in the grades following so that difficult work is done easily by the twelfth graders."

"Mrs. Smith told me you are teaching geometry in the seventh grade, Miss Friend. Isn't that too hard?" Mrs. Public asked.

"The kind of geometry we teach is much easier than the arithmetic we have sent to the twelfth grade. Some of this work was called mensuration when you went to school and is now called intuitive geometry. We measure figures and solids, find their perimeter and areas and volumes and as many facts as possible about them but we still leave formal proofs for the senior high school. This gives us a good chance to introduce our algebra."

"Algebra in the seventh grade?"

"Yes, in the seventh or eighth. When we find areas or perimeters or introduce percentage, beginning algebra is a natural.

After experimenting we make rules, then before we or our pupils know it, we are deriving formulas, and that gives us our first natural taste of algebra."

"Then is algebra taught for several years instead of in the ninth grade like it was when I went to school?" was Mrs. Public's next question.

"You are correct. If children are introduced to one new algebraic idea at a time and given much practice in using it, they avoid the mental indigestion that used to be common in the ninth grade and which was so serious that it resulted in many children leaving school. We teach some algebra in each grade from the seventh through the twelfth."

"Do you mix the subjects all up?" was the next question. "I thought children learned algebra in the ninth grade, and geometry in the tenth."

"Probably those are the names printed on the covers of the text books, but if you look inside these covers you will find there is geometry and arithmetic in the algebra, and algebra and arithmetic in geometry. The walls between the fields of subject matter are crumbling, and children are being taught to use the kind of mathematics that fits the occasion, as they will need to do in life. You know there was a time when children thought they didn't even need to begin a sentence with a capital letter unless they were writing a theme for English."

Since it was time for Miss Friend to teach a class, Mrs. Public proceeded to the senior high school where she again asked to be taken to the mathematics department. When she was escorted to a very attractive room full of equipment, she thought the student guide had made a mistake, especially when he said, "Look around and make yourself at home. The teacher will be back soon. She has taken her class to the visual education room where they are looking at a movie of a foundry. There's lots of mathematics in a foundry."

Mrs. Public's memory told her that mathematics is taught in a bare classroom equipped with a few pieces of chalk, lengths of string, erasers, and a fly specked picture of an ancient bearded mathematician. This up-to-date classroom reminded her of a laboratory. There was a bulletin board displaying current pictures and newspaper clippings telling the story of mathematics as it is reflected in the press. Attractive, highly colored mathematical pictures and posters—a few of which were pupil made—a huge slide rule and graph chart covered the wall.

There were cases of models: some were commercial, some were devised by pupils. There was an old headlight cut to reveal its parabola, a gas meter, sand moulds from a foundry, a scale, a rubber ball with spherical triangles cut in its surface, a sphere on which Lindbergh's historic flight was traced on a great circle. Measuring instruments for field work were stored in a corner cupboard, a library of practical reference books was shelved in a nearby bookcase.

Before Mrs. Public had finished looking at half these fascinating things, the teacher returned and was ready to answer the questions of her visitor.

When asked what all these things were doing in a mathematics classroom, she explained to Mrs. Public that this equipment, is used in making clear abstract ideas and in showing how the mathematical facts involved are put to practical uses. She said that it is one thing for pupils to learn about similar figures and how to prove figures similar, and yet another thing to draw them similar by enlarging a picture or a map with a pantograph. People not only need to know mathematical facts and processes, but how to apply them to new problems that they will meet.

"Not all of us in the department agree as to what topics should be taught, but we all are trying to make the work more practical," the teacher continued. "The boys are far more willing to struggle with puzzling algebra if they find similar difficult formulas in the machinist's handbook over there on the shelf.

"It is much easier to convince the pupils that solid geometry is important if they know that the local manufacturers' association called up yesterday to find the solution of this problem: How many fluid ounces are there in a cylindrical tube whose diameter is two inches and length two feet?

"Our department is trying to make of itself a mathematical clearing house for the community, collecting problems that are actually used here, and to plan our courses so that we will teach the mathematics necessary for the solution of these and similar problems."

"That is a very good idea," Mrs. Public commented. "But this work is certainly too hard for those boys and girls who are not very bright."

"To be sure all of the children are not as bright as your Jim, Mrs. Public," was the answer. "The pupils who do not get along very well in schools used to drop out and go to work, but nowadays almost all children go to high school. The slower children

find the regular courses too hard. At first we used to fill up their programs with commercial work, manual arts, or household arts, but we have learned that they do not excel in work with their hands any more than in work with their minds, and that there are certain facts and skills in mathematics that they must know if they are to get along adequately in life."

"Do these slow children take mathematics in high school?"

"Many of them do. For these slower children we have selected the principles that they are most likely to use after they leave school. We try to show practical applications of each of these topics and introduce them with as many concrete examples as we can find. Of course we teach each idea slowly and have plenty of review. You would be surprised to find out how much these slower children enjoy their mathematics and what difficult work they can do. Often they are quite ambitious and they know, even if we do not, the large wages paid to the trained blue collared worker."

"What do you do for the bright youngsters?" Mrs. Public then queried.

"A few cities have courses especially planned for these pupils. I am sorry to say that we have not done as much as we should since these children are our most important natural resource. However, the original courses were planned for children of high intelligence, so perhaps our delay is not so serious a matter, especially since bright children are more likely to find and solve their own problems."

That evening while Mrs. Public was painting for her husband the picture of mathematics as it is taught today, the educators with whom she had talked again pondered. Certainly times have changed, they thought. National defense is coming to the defense of their subject. It is their responsibility, as teachers of mathematics, to build this mathematical training for defense wisely, with permanent values, planned for everyday use as well as for protection in an emergency. They must remember that in 1941 Opportunity has the same features with which he was pictured by the ancients, a long forelock which can easily be seized as he approaches, but a head that is bald behind.

To perform to the best of my ability the duty I owe my Country shall ever be my highest ambition.—*Perry.*

CONSERVATION TEACHING IN THE FIFTH GRADE[1]

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The title of this paper must not be construed as inferring that the fifth grade has any inherent claim to a study of conservation. It merely indicates that in a certain fifth grade some of the problems of the teaching of conservation in the elementary school have been approached. Although principles and practices of conservation have been emphasized at the University Elementary School of the State University of Iowa for a number of years and especially at the fifth grade level, as will be suggested later, this subject seems not rightly placed in any one grade or in a segregated position in either the science or social studies courses of study. Neither must it be inferred that I come to you with the answers to your problems of the teaching of conservation at any grade level in the elementary school, but rather to discuss with you some experiences with children and conservation in a fifth grade.

Certain issues must be met in placing into our curriculum the teaching of conservation. Five of these I wish to discuss briefly with you.

1. How shall we develop an understanding of the term "conservation"?
2. What are our purposes or main objectives in teaching conservation?
3. What conservation should be taught?
4. How is conservation to fit into the curriculum?
5. How shall conservation be taught in the elementary school?

These points will be discussed in the order listed.

First, how shall we develop an understanding of the term "conservation"? By derivation the term means to keep together. In theory and practice and by definition the term has become quite inclusive. The following definition given by William H. Taft[2] in 1910, for instance, must be reinterpreted: "Conservation as an economical and political term has come to mean the preservation of our natural resources for economical use, so as to secure the greatest good to the greatest number." The term today has been broadened and clarified to specify restoration, as of soil fertility, wild life, and ground water; maintained yield, as of the forests; usage without waste, as of mineral resources; and

[1] Read before the Elementary Science Section of the Central Association of Science and Mathematics Teachers, Nov. 22, 1941.

[2] Speech before Conservation Congress, St. Paul, September 5, 1910.

preservation, as of recreational areas. The interpretations of the term are significant in our teaching. If the children have previously acquired a narrow definition of the term, they may be unnecessarily handicapped in their study. We must decide beforehand what interpretations we are going to give and as a study proceeds, make sure that the children understand these variations in interpretation. Children in our classrooms too often fail to derive meanings because of terminology used by books and teachers. We cannot be too sure that children understand the words indispensable to ideas in a subject of study. A few years ago I was aked to give a demonstration of the use of a sound movie as an introduction to a study. I chose a one-reel film which gave a general survey of the conservation of natural resources. In preparing the children for the movie, we speculated on what was meant by the terms "conservation" and "natural resources." The following interpretations of the term "conservation" were characteristic:

"It means to keep."

"It means to save."

"It means that if we have something, we should keep it for somebody else."

"It means put away so that nobody can get it."

"It means to keep from spoiling."

Before the picture was shown, the children were instructed to find out what the term "conservation" meant and to be prepared to give illustrations of its meaning or meanings. Following the showing one boy displayed his eagerness to settle the issue. When called upon, he responded with great satisfaction to himself, "It means waste. You could see how they were wasting the coal and oil and trees and things." This is illustrative of the problems that arise when children are confronted with terms which they do not understand. This type of situation is discussed in a thesis done at Iowa in 1935 by Barwick[3] on the understandings of science terms and phrases in elementary science books. Barwick found the understanding of science terms and phrases following both reading and discussion to be inadequate. It is entirely possible, however, to present principles of conservation in the lower grades of the elementary school without using the term or any of its sub-terms. In the upper elementary grades,

[3] Barwick, Edna T., "The Meanings Derived by Children from Scientific Terms and Descriptive Phrases in Elementary Science." Unpublished Master's Thesis. State University of Iowa, 1935.

the children will thus have a background of experience which will make the terms meaningful to them.

Local phases of conservation problems probably present our best approaches to the development of the meanings of the term. For example, a school is fortunate to have grounds frequented by birds in winter and is doubly fortunate if the children live in areas where birds frequent yards or parks. An attack on the problem of wild life conservation may be made under these conditions. It seems logical to suppose that an approach to the problem of wild life conservation through local bird feeding and protection would give greater assurance that children would develop more adequate understandings of the term. The term "conservation" may not be used in such cases unless it appears in the reading material. The accumulative understandings resulting from experiences with local phases of conservation problems may well contribute to a broader understanding of the term than could reasonably be expected by approaching the problems through extra-local phases.

Second, what are our purposes or main objectives in teaching conservation at the elementary school level? Our generation and those before us had the fortune, or perhaps, misfortune, of being born in a land, the natural resources of which were thought to be inexhaustible. It is true that this country has been richly endowed by climate and geological phenomena, but not richly enough to follow present and past methods of usage. If you wish to have a good picture of our wealth in resources, may I suggest that you refer to Simonds and Emeny, *The Great Powers in World Politics*, American Book Company, 1935. The record of waste and ill use may yet be seen in the forests, farming areas, and mining areas of our country. It is essential that the story of the use of these resources be written differently by the generations that follow. We have learned that there are certain resources that are non-renewable, an ominous fact; that certain resources are renewable or restorable; and that some resources can be worked on a maintained yield basis. These concepts are being added to the stories of industry today and they will certainly add ballast, stability, permanence to the economy of a great nation.

But we are a great democracy and believe in the democratic way of living. We abhor decrees, being jealous of the ideals of democracy, and therefore prefer to educate our people instead of commanding them. By tradition the schools have been set aside

as an educating institution, and therefore we as teachers must assume, as a purpose, the task of developing conservation consciousness and desirable conservation attitudes in our young people. But that they be imbued with the ideals and principles of conservation seems not enough; someone must practice conservation. Shall we assume that children well grounded in the ideals and principles of conservation will also be practicing conservationists?

An attitude may be sufficiently potential; that is, the individual may have the felt need, as termed by Dewey, but the attitude may never become a part of the individual's behavior because of factors beyond his control. Is it reasonable to suppose that children could successfully plant trees on waste land if they had only a wholesome attitude toward the restoration of forests? The inhibiting factors in such a case would be, for all practical purposes, insurmountable. We may have given the children references, discussion, and pictures, but as yet we have no justification for thinking that they could successfully plant the trees. Granted that they know what to do, they must now learn how to do it. Again we may use the local phase of the problem, the planting of trees by the children. They discover what trees form the local complex, which trees will grow under the conditions of the local problem, where young trees are secured, how to plant the young tree, and what care is required following the planting. They get to watch the results of the planting, and whether the trees live or die, an evaluation of their work is essential. It commonly occurs to the children in this type of procedure that it is easier to talk about reforestation than to plant trees successfully. Our purpose, therefore, in conservation teaching should not be limited to attitudes, techniques in abstract, basic principles, and the history of conservation, but should also include practice in applying those things we have learned.

Third, what conservation should be taught? This point may be partially decided upon the basis of the arguments in the fourth point discussed later. However, as emphasized before, there seems to be no better way to begin conservation teaching than by attacking problems in the local community. These are varied and many are local in nature. An inventory of possibilities may start with the school building or school grounds or may start with a community problem such as the lack of erosion control measures on farms in the neighborhood of the school. One may at first become unpopular by such a practice, but the inter-

est of the children in working on a tangible problem serves well to offset such local feeling. The local situation is not only a good problem, but also provides actual experience in applying conservation measures.

Fourth, how is conservation to fit into the curriculum? Shall it be presented as a special unit of instruction, or shall it permeate the curriculum of science and geography, and, to a certain extent, history? A study of conservation in school presumes that children have sufficient information on an item to recognize that the problem of its conservation exists. From our knowledge of forgetting it is reasonable to suppose that children will have more ready information and understandings on the forests of the United States during a study of such forests than at any subsequent time in their elementary school experience. It is needless then to ask, "Will a child be more likely to recognize a necessity for forest conservation, during his study of forests or at the latter part of the fifth grade?" If one were to teach a unit on soil conservation would it be essential that the children know something about the nature of soils? We cannot minimize the importance of background. Rudolf Bennitt, speaking before the annual meeting of the National Council of Geography Teachers at Chicago, said of conservation, "This field is not a distinct field of learning. It cuts across almost all imaginable lines and is wellnigh universal in the facts, techniques, and ideas that it uses. Rather, conservation is a point of view, a habit of thinking, a philosophy. Its characteristic is simple: to draw conclusions from present and past experience and to extrapolate them into the future. Few teachers would support the belief that this kind of thinking is not essential to every course dealing with natural resources. I should regard it as essential to the teaching of history, civics, sociology, geography, agriculture, and many other subjects. Yet if the 'conservation viewpoint' pervades all of the courses where it can profitably be used, there is then no need for a course in conservation; students can learn in no better way. If it does not, it is unlikely that a lone course in conservation somewhere in the curriculum will establish in boys and girls the habit of thinking into the future."[4]

The fifth and last issue is how shall conservation be taught in the elementary school? It is of major importance that we give the children an intellectual approach to the solution of conser-

[4] Bennitt, Rudolf, "Geography and Wildlife Conservation," *Journal of Geography*, Volume XXXIV, No. 6, September 1940, p. 225.

vation problems. You are aware of the type of material that often appears in print designed to play upon the emotions of the public. These materials often give few or no facts and become, in the end, hindrances to thinking. They present nothing upon which one could base a sensible conclusion; instead, they make the decision and do not divulge the bases for the decision. If we expect to get results from our conservation teaching, we must give the youngsters something to think about after we have stimulated them to the point that they recognize the problem. Suppose, for example, that a notice appears in a local paper stating that the canker worm will probably be bad this spring and that bands should be placed on the elm and apple trees. The dire results are given, but any discussion of how to band is omitted. The children may be highly motivated to attack the problem, but they are helpless because they don't know how. A knowledge of how to attack problems is of first importance in developing conservationists. In conservation problems the following questions demand answer before any assurance of success can be made: a. Where can I find some information on this problem? b. How authentic are these sources? c. What procedures are suggested? d. What evidence is given that these procedures will be successful? e. Which procedure seems most advisable in my situation? The children are then ready to proceed with the preventive measures with a higher degree of confidence. The method is probably of as great importance as the problem, although the problem should always be worthwhile in itself.

Whether the end product is the performance of the conservation measure or not, the procedure in reaching the decision should approximate the above. If the problem be the conservation of forests in the Pacific Northwest, equivalent steps should be followed. The children discover that one-third of the tree remains in the forest as waste. They may say that this should be saved—no thinking yet. Now let us consider what part of the tree this is. What could it be used for? If it were used for the making of compressed wood fiber board, what would the product cost in comparison to the present cost of this board by the present method of production? Would we be willing to pay the difference in cost? Now we're thinking about the problem—the appeal has been made to the intellect and not to the emotions.

In considering any conservation problem, that problem must be defined in such a way that it will make sense to the children;

that is, really be a problem. Further, in solving the problem we must provide experiences which will increase understanding. One does not have to inquire far in classroom discussions or recitations to discover how meaningless problems may become to children. Have you asked children without success to identify an item which had been discussed fluently by them? Have you had children in class who could not respond without repeating the exact words from the text? Have you asked for supporting explanation of a statement without receiving it? This is a problem which we face whatever we teach, the problem of meaning.

But are the schools equipped to increase meaning in their teaching of conservation? Such teaching at the present time must be largely relegated to discussion or teacher telling because reading material not only inadequately provides for the range in reading abilities at any grade level, but most of it is not sufficiently understandable to justify its use at any grade level of the elementary school, unless it be the fifth and sixth. We cannot expect children to reach a depth of understanding essential to the establishment of desirable attitudes unless the reading material is substantially better than that now available or unless the teachers are better qualified to carry the major load as the source of information. Most conservation material on the market today represents only a brief abstract of the information required for constructive thinking in any field of conservation. Neither does this material nor can this material treat of the local conservation problems which provide concrete experiences by participation in the approach to and the solution of an actual problem. There are local problems such as chinch bugs, apple scale, canker worms, bird feeding and nesting, school ground tree and shrubbery care, grass and flower care, city park preservation, mosquito eradication, rat eradication, reclamation of swamp areas, schoolground erosion, tree planting, grasshopper control, prevention of stream polution, etc., which may challenge the resources of all the children in a grade of either a rural or an urban community. But material for the attack of such problems is lacking in our schools. One can find material at the high school or college level which treats the local problem, such as government publications, but to rewrite this material for children of the elementary school is too great a task for the average teacher. We must admit that the schools are not prepared, but we cannot accept this as an excuse for lack of conservation teaching; the resourcefulness of teachers should be greater than this.

As indicated above it is not to be assumed that desirable attitudes will result in desirable conservation practices. Research has indicated that children may be able to reproduce more information on a written examination by observing a laboratory demonstration than by actually performing the experiment themselves. However, we must be interested in more than what they know; we must also be interested in how much of this knowledge they can use in actual situations. I am not aware of research which indicates that a skill such as pruning a tree can be better performed by observation instead of practice. The idea of learning by doing is centuries old. Research does not minimize purposeful practice. Shafer reported in his investigation of the relationship between a knowledge of the principles and laws of physics and ability to make applications at the high school level that "there is little correlation between a pupil's ability to state a principle of physics and his ability to apply it to problems that arise unless he has been forced repeatedly to so apply it."[5] One principle in conservation teaching would seem to be that, insofar as possible, the children should not only learn what to do but should also experience ways by which items may be conserved.

Films, both sound and silent, film strips, slides, concrete objects, excursions, experiments, etc., are widely used in attempts to add meaning to content material, but we lack sufficient evidence concerning their contribution to understanding.

The methods which you will see used in the slides to follow are most commonly used in our fifth grade. It seems logical to suppose that the problem would be more meaningful and that the value of the conservation study would be greater if the children not only knew how to attack the problem, but also were able to successfully apply the conservation measure or measures decided upon. We attempt to provide these conditions through experiences in meeting and solving local problems in conservation.

The opportunities for local application of conservation problems vary, but probably more opportunities exist in the vicinity of any school than that school realizes. Of those possible in our vicinity, the phases most often treated in this fifth grade are as follows:

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[5] Shafer, Benjamin C., "The Relationship Between a Knowledge of the Principles and Laws of Physics and the Ability to Make Applications." Unpublished Master's Thesis, University of Chicago, 1923.

*I. Care of trees
  A. Pruning trees which are damaged by fungus, ice storms, and overcrowding
  B. Pruning trees for general beauty
  C. Banding trees as protection from canker worms
*II. Planting of trees
  A. Determing trees suitable for planting
    1. Identification of trees
    2. Soil, moisture, and shade requirements of the trees
    3. Life expectancy of trees
    4. Usefulness of tree to man, wild life, and in reducing runoff
  B. Digging the trees
  C. Pruning the trees for planting
  D. Digging the hole
  E. Setting the trees
  F. Later care of trees
III. Use of trees
  A. Waste of lumber at a lumber mill in the vicinity
  B. Uses of waste observed at lumber yards
IV. Soil erosion and conservation
  A. Gully control
    *1. Dams
    *2. Rip-rap
    3. Diversion of water from head
  B. Control of runoff from watershed
    1. Terracing
    2. Strip cropping
    3. Contour farming
    4. Rotation strip cropping
    5. Rotation
    6. Contour furrows
    *7. Cover crops
  C. Roadbank protection
  D. Stream control
    1. Blanketing
    2. Jetties
  *E. Measuring slopes
  *F. Experiments:
    1. Rate of runoff
    2. Amount of runoff
    3. Effect of runoff
    4. Deposition of load
*V. Bird feeding
  A. What birds are here during winter
  B. What these birds should be fed
  C. Where they should be fed
  D. Other protection they should have
  E. Observation of results

* Designates that work was done in the classroom or elsewhere by the children. Other items were observed by children on excursions.

It may seem to you that all of the conservation teaching in this fifth grade involves local problems. This is not true. Conservation problems dealing with forests, mineral resources, soil,

and water as encountered in American history, geography, and science are treated as major problems. It is entirely possible, as a result of the study of the local phases of the problems, that the children have a deeper understanding of what conservation really means, a greater interest in conservation, and a feeling of confidence in attacking conservation problems. Children like problems which are dynamic, challenging; which provide a reasonable expectancy of success; and which show results that are measurable.

The activities listed above are representative of the experiences which our fifth grade has with conservation. Objective studies have not yet shown the effectiveness of such experiences. The best measure of the success of these procedures is to discover that a group of the boys in the class is spending two Saturday mornings getting all the elm trees banded out at Fred's house.

VISUAL AIDS FOR SCHOOLS

Where can a teacher get a map for use in her classroom?

Where can the school superintendent or board of education purchase a camera or motion-picture projector for school use?

How can films be used most effectively in teaching today's school children?

The U. S. Office of Education answers these and many other related questions in two publications just issued: "Sources of Visual Aids for Instructional Use in Schools," and "Conservation Films in Elementary Schools." Information supplied is based upon standards of suitability for instructional purposes suggested by the authors.

More than 700 National and State agencies which supply visual aids and equipment for instructional purposes are listed in one of the U. S. Office of Education bulletins. It tells where teachers and school officials may secure maps, charts, lantern slides, mechanical equipment such as cameras and projectors. Supply agencies include Federal and State Government departments and bureaus, colleges, and universities. Also listed are museums, associations, and commercial dealers.

How to select films for use in schools, how to get ready for the film showing, and how to "get the most out of" a motion picture, are suggested in the publication, "Conservation Films in Elementary Schools." Follow-up activities recommended include discussion, experiments, summaries and reports, and pupil evaluation of films shown. An annotated list of films to teach conservation in elementary schools is offered. Author of this bulletin, Effie G. Bathurst, formerly Curricular Problems Specialist on the U. S. Office of Education staff, points out that "it should suggest the further use of films as an available technique for instruction in other curricular materials as well as in conservation."

"Sources of Visual Aids for Instruction Use in Schools" is Pamphlet No. 80 (Revised 1941), single copies 15 cents each. "Conservation Films in Elementary Schools" is Bulletin 1941, No. 4, single copies 10 cents each. Copies may be ordered from the Superintendent of Documents, Washington, D. C.

CAN WE MAINTAIN OUR RENEWABLE RESOURCES?*

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Land resources, including soil, vegetation, animal life, minerals, agricultural and power potentialities, are generally accepted as of basic importance by a modern world. Although social and economic factors have greatly influenced the exploitation of these resources, there seems little need to defend the thesis that in converting these resources into human welfare, waste should be avoided and the future safeguarded in so far as possible.

The division between renewable and non-renewable resources is not as sharp as it might at first seem but it is a very convenient classification dividing the resources which are wholly or partially destroyed by use from those in which conservative utilization does not reduce productive capacity.

To burn a gallon of gasoline needlessly is to destroy and waste that amount of stored energy. To allow the fruit of an apple tree to rot upon the ground wastes the current crop although there is reasonable assurance that the tree will produce again next year. The same is true when large herds of elk or deer are allowed to become emaciated and die due to failure to harvest the surplus and keep the herd in numbers balanced with their range. The gallon of gasoline is not renewable but the fruit crop and the elk and deer herds can be produced again if not completely destroyed.

Waste of renewable resources is less disastrous in the long run than waste of non-renewables. Stored sunlight as coal, gas and oil; ore deposits of iron, copper, zinc, lead and tin are not being replaced at a rate appreciable to their destruction.

Fertile soil may be classified as both a renewable and a non-renewable resource. The mechanical properties of soil involving its characteristic structures, profile and combinations of materials may be permanently destroyed through destructive erosion. In this respect, soil may be considered as non-renewable.

Soil may also be regarded as a renewable resource, one that can be used continously and not be destroyed. This is due

* An address delivered at the Geography and Conservation Group Meeting of the Central Association of Science and Mathematics Teachers, 41st Annual Convention, Chicago, Illinois, November 21, 1941.

largely to the fact that earth materials under a definite climate and definite vegetation cover will develop into a soil as we know it with a definite profile and structure. Soils are only built with a plant cover or, in other words, plant production is a part of soil building, and plant production is not incompatible with soil building.

This, however, we seem not to have fully appreciated in the past. We have destroyed the plant cover by over-grazing, fire, cutting and clearing of forests, and following this destruction the soil has often washed or blown away. In addition, agricultural practices often introduced short season crops, similar to the weedy coverings of over-grazed and eroded lands in so far as soil protection or soil-building is concerned, thus replacing the natural perennial cover. It is not necessary to elaborate on the damages of over-use in western Asia, north Africa, southern Europe, and even in our own country. Land has been lost that will take centuries to replace, if in some cases it ever can be replaced. Man has attacked the deserts with irrigation systems, but, on the whole, he has reduced a thousand-fold more land to desert than he has reclaimed.

Species of plants and animals are not renewable when once exterminated. That is one reason why biologists are now so vitally interested in giving vanishing species every chance to rehabilitate themselves. Animals have disappeared before man became a factor and may continue to disappear. Over a third of the families of mammals and over two-thirds of the hoofed animals are found only as fossils. Man was not the cause of this loss. It is not difficult, however, to point to man in his civilized stage as one of the most destructive agencies; not alone of the animals but also of the forests and grasslands, swamps, lakes, rivers and waters in which animals lived.

The sun is the source of the energy utilized by man upon the earth. Each hour this energy is supplied. The storage of energy is by the green plant cover of forests, grasslands, deserts and water plants, and the cultivated crops which have in places replaced the natural plant cover. This energy was poured on the earth for a third of the age of sedimentation before organisms appeared which could use that energy. Another third had passed before land vegetation became important and man appeared at the very end of the sedimentation period. If the period estimated at a billion and a half years is represented as the twelve-hour face of a clock; man's use of coal, gas and oil began less than

one hundredth of a second before the present. However great the reserves, they are being depleted rapidly and future generations will suffer as a result of this loss.

The energy of the sun, as received, could be utilized to a much greater degree than at present. A little over a third of the sun's energy is reflected out again from the earth and lost while less than two-thirds is absorbed. Only a few percent of this absorbed energy is fixed as plant material, some of which in past ages was stored as coal, gas and oil.

Water is basic to all life and the sun's energy causes its circulation on the earth. Rainfall on the earth is about 30 inches a year. At this rate, a mile of water will fall in 2,000 years. If we accept the age of sedimentation as a billion and a half years, rainfall at that rate would have poured over the earth three-fourths of a million miles of water. This water not only carved out our canyons and valleys and continues to fill our rivers and lakes but it also supports the earth cover of trees, shrubs and grasses. Man's use of these water resources can be so ordered as to maintain or destroy their values. Water flowing to the sea can be used to irrigate land and supply water and hydroelectric power to homes and cities. But conflicts of use develop. It is easy to use these river channels as highways along which to float logs and boats, or to dump into them the wastes of cities and mills or the erosion loss of badly managed farm and grazing lands. To use the water for irrigation, dams are constructed to hold back the water until it is needed on the farm lands. This stops salmon runs and in addition often delivers the young fish to alfalfa fields rather than the ocean where they normally develop. Water flowing down has value as a renewable resource of power. But in order to obtain maximum returns, it is dammed back in flood times to be used at low water. Here additional water surface is valuable for water fowl and often for fish as well. But, changing reservoir water levels destroys the vegetation of the lake shore from which comes most of the food and it also destroys fish spawn. Where the waters are shallow and extend for many miles as at the headwaters of the Mississippi, it destroys nesting sites for ducks. So, in each case there is a legitimate conflict of uses, and it is in this field that the greatest dangers to our maintenance of renewable resources lie. The facts can be obtained, but the interests of the various groups are hard to reconcile.

If the adequate safeguards are hard to secure for a river or a

stream or lake, the importance and the difficulties are tremendously increased when oceanic resources are considered.

Whales could have continued with little diminution if adequate safeguards could have been exercised. The sea otter was soon nearly exterminated by the Russian fur traders and now although probably secured as a species, has lost its great economic significance. Fur seals, without careful control of harvest, might easily go the way of the sea otter. Marine food fishes may be jeopardized by the harvesting of small fish for food and oil or fertilizer. Here in so great a body of water the very extent of the resource is one of the factors tending to endanger its perpetuation. Individual interests, group interests, community interests, state and national interests all clash and tend to favor abuse of the resource. Here again it is not only knowing what to do but of securing a workable plan which equalizes the interests in such a way as to protect the resource from too rapid or harmful use.

The natural vegetation of the earth on which we live was about as follows:

	World	Per cent	United States	Per cent
Forest	21,880,000 sq. mi.	42	1,480,000 sq. mi.	50
Savanas and grasslands	12,670,000 sq. mi.	24	1,060,000 sq. mi.	36
Deserts	17,430,000 sq. mi.	34	434,000 sq. mi.	4
Total	51,980,000 sq. mi.	100	2,974,000 sq. mi.	100

Much of our forest and grassland has been converted into farm land until about half of the land in the United States is in farms of which about half is under cultivation. Roughly speaking, there are about 16,000,000,000 acres of land on the earth lying in a climate favorable for crop production, or about 8 acres for each inhabitant. The welfare of future generations and their standard of living depends upon our ability to properly use this land area.

Agriculture is not a system which has built up farm lands. It is an interruption and interference with natural processes of soil production by man for the purpose of changing that production into forms most useful to him. The soils of value in agriculture, such as the chernozems, prairie soils and podzolic soils, were not developed under systems of soil cultivation.

Present day public efforts to stem the tide of wasteful uses of land are represented by the Soil Conservation Service, the

Agricultural Adjustment Administration, the Grazing Service, and the Forest Service. For many years agricultural agencies have sensed the potential destructive influences in over-use of the soil resource. The Forest Service was established a quarter of a century before the other Federal agencies. The Grazing Service and the Forest Service have the advantage of operating largely on Federal land, but the other Services have the advantage of producing returns for the individual private land owner. Those who use public lands are sometimes tempted during good times to try to secure too great a return from the land since the profits are high, and during periods of depression the temptation is sometimes even greater to over-use the land since such usage seems to be dictated by necessity. On the other hand, the private land owner may, without fully sensing his national responsibility damage his land by over-use under both good and depression periods for temporary gain.

Forest land alone occupies about a third of the land area of the United States. Its value lies in protecting the great watersheds and securing a more uniform flow of silt-free water, avoiding floods, retaining soils, producing lumber, wood and other forest products, providing grazing land for domestic animals and a home for much of the wildlife, besides affording recreational opportunities for millions of people. Although the National Forests are carefully managed and protected; about 85% of the forest land in the United States, much of which is in private ownership, has no proper management, protection from disease or fire, or from wasteful practices.

The private land owner needs help in avoiding wasteful practices in timber or woodland management in protecting his soil, in marketing and in developing new uses for wood products and he needs more equitable taxation on forest lands. The public, if it does this, must be assured that national values will be maintained and that depletion and destruction will be stopped. Millions of acres of cut-over, tax-delinquent and other waste land no longer attractive to the private owner must be publicly administered in the interest of national security.

Where possible, renewable resources should be fully utilized before the non-renewable are called upon to take their place. In other words, water power or direct sun's energy should be used where at all practicable in place of coal, gas, or oil.

Dams which increase power may at the same time destroy wildlife and other values. Changing lake or reservoir levels to

increase or equalize power production is at the same time detrimental in reducing the productivity of the water area and the lake shores. Here, as in most cases of land use, it is the efficiency approach which puts the greatest value on the water which can least be spared, the last acre foot from a reservoir, the last blade of grass from the range, the extra bushel of yield from the land are often the ones which are most expensive when measured on the basis of the whole. Examples could be multiplied indefinitely.

Deserts produce feed for livestock and wildlife. Still the natural productivity is low and even moderate uses may put the "deserts on the march." During a non-productive year the land is stocked for game as heavily as during good years when the stocking is felt to be too low. Therefore, the difficult thing is to survive good years and not emerge with too high a level of usage set in the minds of the public. Conservative use is sometimes difficult to defend on a public basis and on an individual basis in the face of economic pressure. Conservative use in semi-arid farming and in grazing on range lands is essential as is any use of limited natural resources. On the whole, the problems of proper use are largely matters of proper commensurability, of proper balance of various interests; with the maintenance of future welfare of the resource always as a basic consideration.

The Kaibab National Forest was set up in 1906 to preserve a rapidly diminishing mule deer herd. Predators were reduced and deer increased. Finally, they became too numerous. There were more deer than the forage of the area would support. Deer became poor, the best food plants were eaten out. A reduction of deer numbers was essential. But public opinion wanted to protect the deer. They could not realize that protection of the herd required a reduction in numbers. The State resisted all suggestions of an increase of the kill and especially the killing of females. No reduction of rate of increase is possible unless females are killed. The doe at two years produces one fawn and thereafter usually two each spring. The rate of increase is very rapid and even with normal hunting, deer herds in Utah have doubled every three to five years.

Deer were trapped on the Kaibab and finally some of them shot to protect the range. But so depleted had the range become that the natural starvation reduced the deer population to about 1/10 of the maximum number. This loss or waste of a resource was the result not of a lack of knowledge but of a lag in public

opinion and support and the inability to bring together in the interest of the deer herd the opinions of the various interests. Now the forage is on the road to recovery, the deer are increasing in size and vigor. Management will dictate the amount of kill necessary to keep food and deer herd in balance and maintain a continuously productive herd for the hunter.

On the Modoc National Forest in northeastern California a more complicated situation is encountered. It is an old cattle and sheep country. In the early days, a few mule deer of exceptional size and quality did not interfere in any way with livestock use. Lately, a series of dry years have decreased the amount of forage. Reductions of use by cattle and horses have been made gradually from about 35,000 in 1924 to about 22,000 head in 1939. Sheep have been reduced from about 97,000 in 1930 to 51,000 in 1939. The deer herd has increased from about 5,000 in 1921 to 41,000 in 1939. Everthing contributed to over-use of the area. In addition, there was the further complication created by the migration of about 20,000 deer from the Fremont National Forest in Oregon to this Modoc winter range. The California Game Commission has been helpless in that it cannot control the herd by licensing hunters to kill females. The cattlemen and sheepmen see in the deer the cause of the depleted range and point to the reductions they have already made in cattle and sheep. The sportsmen say the cattle and sheep are responsible for the condition. Oregon is not too much concerned over the condition of the California range and the California sportsmen cannot kill the Oregon deer since they migrate into California after the hunting season has closed. To sum up, Oregon, California, the cattlemen, the sheepmen, the hunters, the Forest Service, the ranchmen who often have the deer wintering on their private lands, are all interested. The Forest Service knows that its range is being over-used. It is easy to plan a reduction to the physical carrying capacity of the range, but the solution of the problem lies largely in the fields of economic and social adjustments of the interests of the various groups concerned. Even if all the others could agree that the deer herd should be reduced, the California legislature would have to be convinced for they alone have the power to authorize a doe kill on this range.

Some of the problems confronted by management agencies are difficult from the physical as well as from the social and economic side. Suppose for instance, that on winter range A the

forage is as follows: 10 percent grama grass, 10 percent bitterbrush, 10 percent juniper, and 70 percent sagebrush. Range B has 30 percent grama grass, 30 percent bitterbrush, 30 percent juniper and 10 percent sagebrush. Deer prefer bitterbrush and juniper, and will use sagebrush when forced, but do not use grama grass as winter forage. Cattle prefer grama grass, will browse bitterbrush and some of the sage, but seldom touch juniper.

In considering deer use, should the deer be numerous enough to destroy the bitterbrush and juniper when each produced only 10 percent of the total forage? A very light stocking is necessary if bitterbrush is to be maintained. But once lost, the next 10 percent becomes the preferred food. So bitterbrush, and juniper disappear and we have a grama grass and sagebrush range. This is very poor range for deer. But what shall be done when bitterbrush constitutes 30 percent of the forage? Shall we allow the herd to become large enough to reduce the first preferred food when it is 10 percent on Range A and try to save it when it constitutes 30 percent of the forage on Range B?

Suppose we are using the same area for cattle, the picture will be very different. Grama grass will be preferred and disappear along with bitterbrush but juniper and sage will survive. In other words, deer winter use reduces the range to grama grass favorable to cattle. Use by cattle reduces the grama grass and favors juniper and sage, making it somewhat more favorable for deer. Deer eat juniper but sheep do not. Often deer die on good bunchgrass and grama grass range for lack of food where cattle or sheep would thrive. On the other hand, juniper is valuable winter feed for deer but useless to cattle and sheep.

In Utah deer are destroying winter range by eating out juniper and sage and favoring grama grass, and in Wyoming elk are reducing winter brush range to grass range, chiefly useful to cattle in summer when the elk are on the summer range.

The question here seems practically impossible of solution, except perhaps on a mathematical or philosophical basis. As soon as one preferred food is consumed, the next in order is taken. Therefore, grazing land, whether used by domestic animals or herbivorous game animals, progressively becomes less suitable for the type of animal using them. In other words, even with feed on the ground the range may be rapidly deteriorating in quality. This consideration points to the desirability of a rotation of use or better to a balanced and conservative use by

different types of livestock and game if good results are to be attained.

The bunchgrasses of California and the Northwest have been destroyed and have given way to crops of annual brome grass known as cheatgrass. On the high plains short grass has been partly destroyed and weeds have taken their place.

Those who see only in terms of their own desire or of their own interests are not safe guides to conservative uses. Only by a balance of uses, by a proper protection of soil and vegetation can the dependent population of animals be assured. Whatever may be the desires of the naturalist, the sportsman, or the recreational groups, the livestockman and lumberman, the limits of production are dictated by the physical conditions of the habitat and not by the social or economic considerations. However, when it comes to a balance of uses the economic and social surveys should aid in directing a reasonable program.

Can we reconcile the desires of competing groups in such a way as not to over-use our renewable resources to the point of destruction? Competition for the opportunity to profit by overuse of renewable resources leads most surely to their destruction or depletion. Therefore, economic and social studies should attempt solutions of the commensurable use when physical studies have fixed the maximum safe use, if our renewable resources are to be maintained. The demands for efficiency and maximum production which are too often implements of destruction when applied to renewable resources, should not be mistaken for the demands that waste be avoided. In other words, economic surveys and social surveys can only settle the questions of relative need or desirability of types of use but have no way of determining the amount of use compatible with the perpetuation of the resource. Too often such surveys fail to give proper consideration to the physical features such as soil and plant cover which in themselves determine productive capacity irrespective of economic pressure. This must be clearly recognized if renewable resources are to be maintained.

EDUCATION AND VICTORY

"Education makes good men, and good men act nobly, and conquer their enemies in battle, because they are good. Education certainly gives victory, although victory sometimes produces forgetfulness of education; for many have grown insolent from victory in war, and this insolence has engendered in them innumerable evils; and many a victory has been and will be suicidal to the victors; but education is never suicidal."—*Athenian in Laws 641 C.*

SOME OBSERVATIONS ON THE TEACHING OF CHEMISTRY

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Various transcontinental trips, going and returning each time by a different route, have enabled the writer to visit a good many schools. Observations have been made in the chemistry classes, both in the recitation room and the laboratory, and conclusions have been drawn based upon these observations. It would be idle to say that these observations and the conclusions drawn therefrom are general, for there must be many schools where these would not apply; but they do apply in the schools visited and it is thought they may also apply to a good many others. Not all the comments listed below apply to any one school, but have been gathered here and there. I note:

1. Inadequate use of the demonstration. In many schools teachers are not using this method at all. In reply to the question: "What are you doing in demonstrational work?" the reply has been received: "Oh, we don't do anything with that here, you know!"

In other schools, teachers are using the demonstration, but too often selecting as the subject one of the laboratory experiments listed in the manual in use. This method may be defended on the ground that the first few weeks of the year pupils need to be shown the correct set-up of apparatus and the proper modes of procedure as the experiment progresses to its end. But this method should soon be abandoned since, if continued, it destroys any sense of newness the pupil may have as he comes to the next experiment. In some schools adequate demonstrational work is done.

2. Dependence on the text. Often enough teachers have been seen to sit with the text wide open before them and the recitation followed in this way to the end. This does not inspire much class confidence in the teacher when he must consult the text to decide whether Johnny has answered correctly the question asked. The instructor who is master of his subject should be able to teach the chemistry of hydrogen or ammonia or any other topic without reference to the text; such teaching inspires class confidence in the instructor. It is not a difficult matter to read over the lesson before school, decide on what demonstration you will show, what questions you will ask, how you will de-

velop the topics, etc. Once in a while reference to the text may seem necessary when it is evident that the student or the class has missed an important point in the lesson for the day, or to stress some principle of importance, or to refer to a drawing of a piece of apparatus, but in general it is better to let the textbook lie on the desk unopened.

3. Lack of originality or resourcefulness. Often, during the recitation, something comes up which suggests a question on the part of the student. For example, Bill has recited on Priestley's experiment, stating that mercuric oxide, when heated decomposes into mercury and oxygen. Up goes Joe's hand. "Would copper oxide act the same way?" Now the text says nothing about the effect of heat on other simple oxides. The teacher may answer Joe's question, but it is better not to do so. Let Joe come to the desk; let him be given a test tube into which he introduces some black cupric oxide; let him apply heat, and test to find if oxygen is set free. In two minutes Joe has answered his own question. Then may follow the general question by some member of the class: "Are we to conclude that all simple oxides are not decomposed by heat?" Again the question may be answered by experiment. Let three or four pupils come to the desk and find out for themselves the answer to the general question. As a rule this is far more effective than telling by the teacher.

Again Helen has recited correctly on the reaction between dilute sulphuric acid and zinc. Up goes Walter's hand. "Could you use copper, or silver, or aluminum, or sodium?" Here again let Walter come to the desk and satisfy himself as to the results when a dilute acid is put in contact with such metals as mercury or copper; of the marked action when metals higher in the displacement series are used.

Numerous other instances might be cited. It is granted that this takes more time than would be required to answer the pupil's question directly, but the preferred method is the one which requires the pupil to stand on his own feet and find out for himself the truth in the matter. For after all it is the chief business of the teacher to teach pupils to *think*, not to stuff their heads with a mass of unrelated facts.

4. The Displacement Series. The compilers of our texts in chemistry are to be blamed for delaying so long the introduction of the Displacement Series. I would introduce it as early as the chapter on Oxygen. How are you to explain to Johnny and

Jennie why mercuric oxide is readily decomposed by heat while the oxides of metals higher up in the series are not so decomposed? Let Arthur come to the desk and point out the position of mercury in the table. Let the class observe (adroit questioning being used) whether other metals, such as platinum, gold, silver form oxides. Does it appear that these metals have only a slight hold or none at all on oxygen? It has previously been shown experimentally at the desk (See 3) that the oxides of the metals higher in the series are not decomposed by heat. From a careful development of the information drawn from the class, they can be brought to see something of the value of the displacement series as an aid in determining the action of different metals under varying circumstances.

Again under hydrogen the teacher may discuss the position of those metals which do, and those that do not, react with the non-oxidizing acids. Experimental demonstrations on the relative activity of such metals as: potassium, sodium, calcium, amalgamated aluminum, and zinc will help to fix in mind the importance of the table.

5. General principles. Our modern texts contain such a monumental mass of factual information that the importance of the *general principle* seems not to receive the attention it deserves. Given any series of related reactions, there must be one underlying general principle which includes them all. For example, Mary recites on the preparation of ammonia; she says what the book says, that ammonia is prepared by the reaction of ammonium chloride and calcium hydroxide. But you can call to the desk student after student to try such combinations as: ammonium nitrate plus barium hydroxide, ammonium sulphate plus sodium hydroxide, ammonium oxalate plus potassium hydroxide, and so on. Given six ammonium salts and four bases, how many ways are there to prepare ammonia? Now up goes Albert's hand: "Well, then, why does the book specify ammonium chloride and calcium hydroxide?" It would be easy to answer this question but it is better to appoint a committee of three to consult on the spot a dealer's price list; it is soon discovered that this particular combination is the cheapest one, and therefore . . . . Now up goes Isaac's hand: "Why do we have to have a base? Couldn't we use an acid just as well?" Again we could answer this question, but it is better not to do so. Instead we may proceed thus: "What is the composition of every ammonium salt? (An acid combined with ammonia gas.)

"What is required to neutralize an acid?" (A base.) "If the acid component of an ammonium salt is neutralized, what will then happen?" (Ammonia gas is set free.) Whenever the pupil can be brought to answer his own question, the teacher should resort to some such method as that above. Don't tell them everything.

6. Investigations. Often some question arises which suggests an investigation. For example, a pupil recites that lime, CaO, is prepared by heating limestone, $CaCO_3$. This suggests an investigation as to the effect of heat on other carbonates; the book says nothing about that. Let Carol, Don, Julia, and Miriam come to the desk. To the first is given a clean crucible containing lead carbonate (white); to the second copper carbonate (green); to the third cadmium carbonate (white) and to the fourth some other carbonate, cobalt carbonate perhaps. Each pupil heats his specimen. #1 reports: "My white lead carbonate is turning tan color!" #2 reports: "My green copper carbonate is turning black!" #3 reports: "My white cadmium carbonate has turned brown!" and #4 reports: "My cobalt carbonate is showing a color change!" "Well, certain conclusions may be drawn; what are they, class?" And Bud says, "I guess all carbonates are decomposed by heat!" Very good; but how about mercuric carbonate? And Bud has to admit that the oxide which might be formed is still further converted into mercury and oxygen, and Priestley's experiment is brought in to prove that point. The original statement must now be modified to fit this additional information. It can be shown that sodium carbonate, which sizzles when acid is added to it, also sizzles just the same after heating. Again our judgment must be modified to comport with the facts. Finally we arrive at the conclusion that the carbonates of the metals midway of the displacement series are decomposed by heat into the oxide and carbon dioxide; the metals high in the series have carbonates not easily or not at all decomposed; the metals low in the series, such as silver and mercury carbonates, are decomposed with the resulting oxide also reduced to the metal. Now all this takes time but it is worth it. Similar investigations may be made here and there.

7. Procedures. Insufficient instruction is often given in the case of simple laboratory procedures. This has been noted in the college and university summer schools, much to the author's surprise. Bunsen burners out of adjustment and the student apparently unable to correct the fault; ring stands in wrong

position; filtrates falling several inches into the center of the receiving dish; evaporations conducted with full heat of the burner to the end with consequent spattering of material; very poor glass bending (worst of all at a well-known university); pupils pouring dry chemicals from a bottle into a test tube or flask with most of the material going onto the floor; and various other instances have been noted. It seems such a simple matter to give adequate instruction in these elementary but quite necessary matters during the first weeks of the course. It is just as easy to do a thing right as it is to do it wrong. Pupils make these errors, not knowingly or meaningly, but just because of ignorance; ignorance so easily corrected with adequate teaching and laboratory supervision. But one must keep everlastingly at it.

8. Projects. Many teachers seem to have no arsenal of projects, simple ones, from which they may draw for the occasional bright student who is qualified to undertake work of that sort. To offer the pupil additional experimental material in the manual which he has been using, does not seem to fill the bill. It is better to offer an excursion into some field of individual interest, an avenue of escape from the ordinary routine of the laboratory into an area of personal desire. But such material does not seem to be general among teachers.

9. Laboratory. Classes in the laboratory have been observed to engage in general visiting, laughing, scuffling, and general inattention to the work of experimentation; and this often under the eye of the teacher. Some instructors apparently pay little attention to the students in the laboratory, since they have been observed to be writing letters, filling out records, looking over their collection of stamps, etc. It is not to be understood that the preceding statement refers to a common fault, for it probably is not common; but it has been observed in some instances.

10. Telling. It is a general fault that teachers talk too much. It has been noted that when a visitor arrives, the teacher feels that now he must display his own knowledge with the result that he takes up the greater part of the period while the class sit and listen—or just sit. Now it may be assumed that the instructor has a reasonable command of his subject or he would not be in his present position. I do not visit his class for the purpose of observing his display of information, but, rather, to observe how skillful he is in drawing out of his students the desired information; in teaching them to observe, to think, to

stand on their own feet; in short how efficient he is in developing the powers of his youngsters. That constitutes real teaching in my judgment. There are, of course, frequent instances where the teacher must "lecture." You cannot demonstrate Avogadro's Hypothesis, and no amount of questioning, however adroit, can draw out of a pupil the structure of the sodium atom. These, and other similar cases, make it necessary for the teacher to explain, to illustrate, to endeavor in various ways to get the idea across to his class.

But in the general run of topics, teachers should talk less and spend more effort in the harder but more satisfactory way of drawing out of the students the desired information. Thinking is hard work, but it is one of the indispensable factors in real education.

11. Elan. Teachers have been noted who sit like a statue, without a sign of enthusiasm, motionless as Memnon, but not like him moved to song by the rising sun. How can any teacher expect to arouse interest, waken enthusiasm, and make the subject interesting who is not himself alive, alert, enthusiastic, interested in what his pupils are doing?

Now since these criticisms may seem a little hard, let us look at the other side of the shield. It has been noted that:

a. Many teachers are carrying too heavy a program. They have a class every period in the day, and often a series of different subjects. They have little or no time to set up apparatus for demonstrations, and to do many other things which good teaching calls for because of the limitations under which they work.

b. Teachers who have had their special work in history or mathematics are sometimes called upon to take a class in chemistry, a condition wished onto them by their headmaster due to certain exigencies in program making. Such a teacher can hardly be expected to deliver first-class instruction in a subject for which he has not had the necessary preparation.

c. Many of the younger teachers have had little experience since they are only a year or two out of college or normal school. These may be expected to improve as time goes by.

d. Many teachers are handicapped by the endless red-tape wished onto them by their superiors. Much of this has repeatedly been shown to be useless, but the teacher, willy-nilly, has to do it. This consumes time, energy, which might better be expended in the real work of teaching.

e. Salaries in many instances are too low to permit the employment of high-grade teachers.

f. Lack of proper equipment, in some cases, may account for the lack of suitable demonstration work.

The faults observed are numerous enough to be sure, but some, at least of these, might be eliminated or reduced if teachers were given a better chance to show what they can do.

REPORTS OF NATION-WIDE CENSUS OF EDUCATION

Printed reports of an educational census that reaches into every community in the United States where there is a school or college have just been issued by the U. S. Office of Education.

This Nation-wide census is the Biennial Survey of Education in the United States. It is directed by the U. S. Office of Education at the request of Congress to show the condition and progress of education. Five published reports bring together statistics and facts voluntarily supplied by more than 30,000 State, county, and city school systems, public high schools, colleges and universities.

A "Statistical Summary of Education," presented as chapter I of the biennial report, gives an over-view of the most significant trends in American education—facts gleaned from the other four Biennial Survey chapters. It suggests what types of detailed information and statistical reports are available in the 1,000 pages of the other four publications. This "Statistical Summary" has 40 pages. Its price is 10 cents.

Other chapters reporting findings of the Biennial Survey of Education in the United States are:

Statistics of State School Systems, Chapter II, 20 cents.
Statistics of City School Systems, Chapter III, 35 cents.
Statistics of Higher Education, Chapter IV, 45 cents.
Statistics of Public High Schools, Chapter V, 15 cents.

Copies of the educational census reports prepared under the direction of Emery M. Foster, Chief, Division of Statistics, U. S. Office of Education, are available from the Superintendent of Documents, Washington, D. C. The complete set of five chapters costs $1.25.

WATER REPELLENT JACKETS

Water repellent jackets are now being issued to Army men. The jackets are made of closely woven cotton poplin, lined with wool where added warmth is required. The cotton is chemically treated at the mill with a water repellent, which also resists spots, stains and perspiration. Non-greasy spots and even soup spills can be sponged off with a damp cloth, or even washed away with a dash of water which the cloth sheds. Yet unlike rubber or leather coats, the new garment allows the body to breathe. It is durable and can be repeatedly dry-cleaned or laundered.

WHAT CAN BE DONE IN ALGEBRA?

A Study of the Relation between the Table, Verbal Statement, Formula and Equation, and the Graph

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I. INTRODUCTION

In the teaching of high school algebra it is a common practice to study the table, graph, verbal statement and the equation, and the formula as isolated units, having no particular relationship to one another. A study of each of these forms involves functional thinking, i.e. understanding the relationship between variables.[1] Failure to show the similarities existing between these functional forms deprives the pupil of several useful generalizations that are applicable in his thinking even outside a class in mathematics.

In our thinking we frequently come to conclusions or make generalizations after discussing a few particular cases of the point at issue. Consider three following reasoning situations:

1. "The beans have burned again.—Electric stoves are just no good!"
2. "Margaret used the CURE ALL tonic when she had this ailment.—Anybody who has this ailment should use the CURE ALL tonic."
3. No marriage licenses were issued to Negroes last week. Last week was the first week for the enforcement of the new law requiring blood tests of applicants before the issuance of marriage licenses.—"Negroes are afraid to have blood tests taken."

These situations illustrate an incorrect use of a thinking process. However, this particular thinking process is basic in the logic of algebra and geometry.

It is my belief that a critical study of the methods for reaching conclusions by induction would tend to help pupils become more cautious in the use of unqualified generalized statements. It might also result in the pupil's becoming more aware of the need for considering a sufficient number of representative samples before drawing conclusions like those in the illustrations cited. My belief is based on the assumption that teachers will be willing to consider the potentialities of certain materials not usually included in the conventional courses in albegra.

Much of the present material in algebra means very little to the pupil either because he has had no part in assembling the

[1] *The Seventh Year Book: National Council of Teachers of Mathematics*, The Teaching of Algebra, p. 55.

data, and formulating generalizations (axioms), or because the problem situations are too artificial. Hence, there is a definite need for more purposeful experimentation toward discovering and using more meaningful teaching material for algebra. The material might be collected by the class during a class experiment or a demonstration experiment performed by the teacher.

This paper is to formulate certain procedures that may help pupils acquire a general view of the functional forms previously mentioned. The following material does not represent an organized unit. However, there are certain suggested activities from which one may make selections appropriate for a particular situation. These suggestions are designed to demonstrate by example certain ideas involving Data and Function expressed in "Mathematics in General Education."[2]

II. Objectives Involved in Interpretation of Data

The ability to think clearly is one of the basic needs of every individual. Young people need especially to develop more and more effective methods for solving their various daily problems. Realizing that there are many other needs that may be fulfilled by courses in mathematics, our main objective will be that of "development of effective methods of thinking,"[3] using the previously mentioned functional forms. This work involves several phases of thinking, including interpretation of data.

An analysis of behaviors involved in interpretation of data may include the following abilities:

1. Ability to perceive relationships in data evidenced by:
   - 1.1 An understanding of the meaning of symbols employed.
   - 1.2 Ability to find the value of a variable when the other variable (or variables) is known.
   - 1.3 Ability to perceive the relationship between two calculated values of dependent variables when the independent variable is increased or decreased by
     - 1.31 doubling, halving, etc.
     - 1.32 adding or subtracting a definite amount.
     - 1.33 a certain per cent.
   - 1.4 Ability to relate steepness of slope in line graphs to rate of change.

[2] *Mathematics in General Education*, Commission on Secondary School Curriculum, Appleton-Century, 1940.

[3] *Evaluation in The Eight Year Study*, Tentative Report, Chapter 1.

1.5 Ability to relate like characteristics in different types of data.

2. Ability to recognize the limitations of data[4] as evidenced by:
   2.1 Ability to recognize and use the kinds of data appropriate for particular situations.
   2.2 Ability to extrapolate
      2.21 Predicting values of dependent variables when the independent variable is greater than the largest independent variable listed in a given table of data.
      2.22 Predicting values of the dependent variable when the independent variable lies beyond a given graph as plotted.
   2.3 Ability to interpolate
      2.31 Finding values of the dependent variable in a given table or graph when an intermediate value of the independent variable is given.
   2.4 Recognition of the domain of data
      2.41 Ability to decide "how far one can go" in using a certain relation, e.g. knowledge of the fact that negative numbers have no meaning in a formula which gives the cost for a certain article.
3. Use of experimentation to discover relationships as evidenced by:
   3.1 Recognition of necessity for accurate measurement in securing reliable data.
   3.2 Recognition of necessity for representative sampling before making general statements.
   3.3 Ability to fit data (approximately) to a curve.

III. Criteria for Selection of Material

The selection of material for the unit should be based on some of the following criteria:

1. Is the material significant to the economic and social life of the individual?
2. Is the material significant in understanding the relation of mathematics to science and other fields of knowledge?
3. Is the material significant to the students in understanding and appreciating their natural environment?

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[4] *Evaluation in the Eight Year Study*, Tentative Report, Chapter II, page 2.

4. Does the material provide opportunities for expression and communication?
   4.1 Possibilities for interpretation of data.
   For example:
   Interpolation (computation of intermediate values)
   Extrapolation (extension of the curve which best fits the known data)
   4.2 Possibilities for revealing functional relationships.
   For example
   Dependence
   Variables
5. Does the material provide opportunities for computation?
   For example:
   Rounding off numbers
   Accurate arithmetic work
   Quantitative relationships, such as "constant rate of change"
6. Is the material plentiful and reasonably accessible?[5]
7. Is the material at the maturity level of the student?

IV. How to Secure Data[6]

The class may secure data: (1) by experimentation; (2) from various community sources, e.g. from the Chamber of Commerce; National Safety Council; bus, railroad and airlines stations; telephone and telegraph companies, etc. (3) sources such as the U. S. Census and the World Almanac; or (4) by the teacher with explanation to the class of how the data were obtained.

If the work is to be concerned with a defining formula as $f = 3y$, where f = feet and y = yards, the data may be given to the class or the class as a group may work out a table. The second method as listed above seems especially preferable, if the class is to participate fully in the study.

If the work deals with the empirical formula, method (1) seems preferable. However, the complexity of the experiment, the length of time required for its performance, and the size of the class are factors to be considered. These factors determine whether the experiment should be performed by class groups, by the teacher, or whether the data should be presented with proper explanations. During the year each of the methods should

[5] *Mathematics in General Education*, p. 91.
[6] *Mathematics in General Education*, p. 388; pp. 408–411.

be tried in order to determine which will produce the greatest amount of pupil growth in desired abilities.

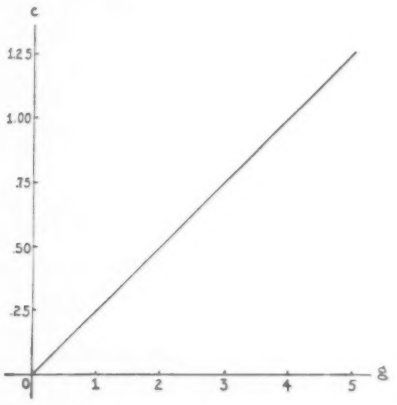
V. Suggested Activities

The group might begin with a tabulation of data on measured perimeters of sets of equilateral triangles or squares with progressively longer sides. Data showing the relation between the distance traveled by a car during the driver's reaction time and its velocity may be presented using the formula $d = 1.5V$; where d is distance and v is velocity.

A different beginning may be made with a tabulation of data on the cost of gasoline. Such a table would have the following form:

Gallons	0	1	2	3	4	g
Cost	0	.25	.50	.75	1.00	c

The class might discuss the table noting the constant differences in each row and the relation between the two differences. From this a general verbal statement might be derived such as: The cost of the gasoline is always 25 times the number of gallons.



The matter of economy in expression could be brought into the discussion by agreement on certain symbols for cost and gallons. These symbols may be added at the end of the rows. Then the class may be able to state the formula $c = 25g$. (result in cents)

The class may next be shown methods for stating this rela-

tionship graphically. The bar graph might first be used since the staircase arrangement might cause the class to see the possibility for the newer and simpler arrangement of drawing a line through the midpoint of the upper end of each bar. This experience may be used as a basis for understanding the usual method for drawing the line graph.

The concepts and skills necessary for an understanding of these relations can be developed by repetition, using different materials. Suggested materials might include first class mail postage tables, tables of wages, interest tables, experiments on the relation between the diameter and the circumference of circles.

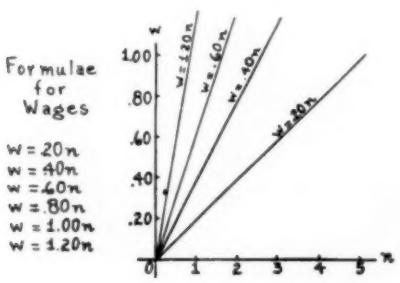
The next stage, that of generalization, is most important. Here statements concerning the relations between the four functional forms are made. A general statement of the form of each formula, e.g. $y=ax$, is made with a differentiation between the meanings *attached* to y, x, and a.

The concept of ratio or slope may be used to show that the graph presents the same information as the constant differences of the table, the *coefficient* of the independent variable in the formula and the number used in the verbal statement.

The relation between the steepness of a graph and the coeffi-

TABLE OF WAGES

Number of Hours	Wage Per Hour				
	\$0.20	\$0.40	\$0.60	\$0.80	\$1.00
0	.00	.00	.00	.00	.00
1	.20	.40	.60	.80	1.00
2	.40	.80	1.20	1.60	2.00
3	.60	1.20	1.80	2.40	3.00
4	.80	1.60	2.40	3.20	4.00
5	1.00	2.00	3.00	4.00	5.00



cient of the independent variable may be shown by using a "group" of formulas, say for wages, with the corresponding tables and graphs.

The student should be shown now how to use this type of formula. Finding values of the dependent variable when the independent variable is known involves the technique of substitution. The problem of finding the independent variable when the dependent variable is known involves the division axiom.

The advantages and disdvantages of each type of data can be discussed at this point, e.g. the table presents only limited data. The formula enables one to find either variable for any amount within the *domain* of the variables.[7] Finding intermedidate values and values outside the range of the graph or the table can only be approximated. The graph gives a clearer picture of the rate of change than does the other forms.

A further use of the formula can be discovered by changing the subject, i.e., the form can be "ready made" for use in finding the independent variable, given any value of the dependent variable.

All of the generalizations should be recorded by the student in an orderly manner. A notebook or pupil-made textbook with sections on axioms, generalizations on the straight line graph, etc. is a suggested plan.

The significance of such empirical formulas as $c=2\pi r$ and $W=Kl$ might be explored at this stage. Most pupils will already know the meaning of the formula $c=\pi r$; the problem will be that of understanding clearly the origin of Pi. A number of $\frac{1}{4}''$ or $\frac{1}{2}''$ thick wooden discs of different diameters might be used for this experiment. The diameter and the circumference of each could be measured using a heavy string and a ruler. The results obtained by various groups of pupils might be recorded as follows:

Greatest Distance Across Disc	Distance Around Disc	
	Group 1	Group 2
0	0	0
3″	9″	9.125″
6″	$19\frac{1}{4}''$	19.25″
9″	$27\frac{1}{2}''$	27.5″
12″	37″	37.675″

[7] *Mathematics in General Education*, p. 52.

Using their experience from previous work, the class might generalize in this manner: The distance around the circle is *always slightly more than three times the diameter.* The use of the average may be shown here in deciding upon the value of the accepted constant, Pi.

From the generalization a tentative formula, $c = kd$, can be established. Then each set of measurements can be substituted in the formula in order to obtain values for k as:

$$c = kd$$
$$19.25 = k.6$$
$$\text{or} \quad 6k = 19.25$$
$$k = 3.208$$

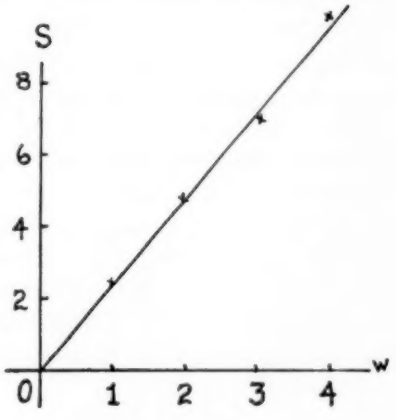
The average of the "k's" will give the value of Pi.

An alternative method would be that of plotting points representing values of c and d on a set of axes. The arrangement of these points will suggest a straight line. From this straight line the average or Pi can be approximated. This experience in graphing and generalizing should be applied directly to new cases involving the same type of formula.

Data for formulating Hooke's law of physics ($S = kw$) could be assembled by measuring with a ruler the stretch of an old inner tube, using several bricks as weights and assigning unit weights to the bricks. The relation between the stretch of the tube (S) and the increase in weights (w), could thus be studied. A detailed explanation of a similar experiment will be found in *Mathematics for the Million.*[8]

Let us suppose that the following data were obtained from the experiment:

Weight w	Stretch S	Successive Differences (k) in Stretch
0	0	0
1	2.3	2.3
2	4.7	2.4
3	6.9	2.2
4	9.8	2.9



[8] *Mathematics for the Million*, Hogben, pp. 414–418. W. W. Norton & Co.

The graph and the table each reveal an approximate linear relation between S and W. A tentative formula, $S=kw$, can be accepted, the problem being to determine a value of k that would best fit the data.

By using all possible pairs of values for S (in this case six different pairs), substitutions in the tentative formula will give 6 values of k. Each value of k is substituted in the formula to give a computed S. The difference between the computed S and the measured S should then be determined. The curve of best fit is the one which gives the smallest value for A in the formula:

$$A=\sum[d]/n^9$$

This is not the best method for determining the curve of best fit but it is adequate for high school work.

The work should be done as follows:

Substituting values for w and S in the formula $S=kw$ we get:

$2.3=k\cdot 1$ $4.7=k\cdot 2$	$2.3=k\cdot 1$ $6.9=3k$	$2.3=k\cdot 1$ $9.8=4k$	$4.7=2k$ $6.9=3k$	$4.7=2k$ $9.8=4k$	$6.9=3k$ $9.8=4k$
$7.0=3k$ $2.3=k_1$	$9.2=4k$ $2.3=k_2$	$12.1=5k$ $2.4=k_3$	$11.6=5k$ $2.3=k_4$	$14.5=6k$ $2.4=k_5$	$16.7=7k$ $2.4=k_6$

Computed Values of S

$S_1=2.3w_1$	d_1	$S_2=2.3w_2$	d_2	$S_3=2.4w_3$	d_3	$S_4=2.4w_4$	d_4	$S_5=2.4w_5$	d_5
2.3	0	2.3	0	2.4	.1	Same		Same	
4.6	−.1	4.6	−.1	4.8	.1	as S_1		as S_3	
6.9	0	6.9	0	7.2	.3	Same		Same	
9.2	−.6	9.2	−.6	9.6	−.2	as S_1		as S_3	

Using the formula, $A=\sum[d]/N$, for each set of d's the values (by coincidence) of A are .7/4. Hence the curve of best fit is either: $S=2.3w$ or $S=2.4w$.

Work could be allotted to groups, one group reporting on S_1, another on S_2, etc.

At this point, some consideration should be given to a study of the quantitative effect of increasing or decreasing the independent variable by adding or subtracting a constant. This study would involve the operation of multiplying a binomial by a monomial and is discussed fully in *Mathematics in General Education*.

[9] *Mathematics in General Education*, pp. 396–397.

Using a similar method, data can be secured for a study of the forms: (2) $y=ax+b$, (3) $y=ax^2$, and (4) $y=ax^2+bx+c$.

Data for form (2) can be secured when the following types of problems are considered: (a) taxi fares where the total fare is a certain amount for any distance up to a specified mileage with an additional amount per additional fraction of a mile, (b) salaries in which the worker is paid a certain amount per day plus a commission on his sales, (c) parcel post rates, (d) long distance and telephone rates, (e) telegraph rates, (f) relations between temperature scales, (g) selling price of an article, ($S=c+rc$), (h) charts showing relation beween blood pressure and age for work in curve fitting. Work in determining the proper formula would proceed in a manner similar to that described in Hooke's Law.

In beginning the study of the relation, $y=ax^2$, the area of the surface of a cube and of 2, 3, and 4 cubes placed end to end could be considered. Here the constant a, can be determined by inspection of the formulas $A=s^2$, $A=6s^2$, $A=10s^2$, $A=14s^2$, and $A=18s^2$.

By varying the area of the faces of the cubes a table of this type may be obtained:

s	0	1	2	3	4	5
A	0	1	4	9	16	25

From this table a graph can be drawn and a study of the first and second differences in the dependent variable made. One tentative generalization is that the second differences of the dependent variable in the second degree form are constant. Another generalization is that the constant a, for one face of a cube, a square, is 1.

Succeeding work on cubes may serve as the introduction for more advanced work in determining the value of the constant, Pi. Two methods will be described:

Several circular discs with radii of different lengths are cut from heavy cardboard. (The heaviness of the cardboard selected for use should depend on the sensitivity of the available scales.) These cardboard discs are weighed separately. The weights and radii are then tabulated as on the following page.

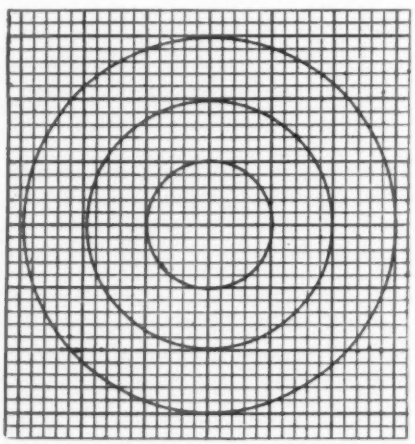
The teacher makes personal use of the formula, $M=Ahd$, where M = mass or weight, A = area, h = height or thickness and

d = density. The mass of a piece of cardboard of unit area would be calculated as $M_0 = 1.h.d(1)$. The mass of the cardboard circle with radius equal to unity would be: $M_1 = A_1hd(2)$. Dividing equation (2) by equation (1) we get: $M_1/M_0 = A_1hd/1hd$ or $M_1/M_0 = A_1$. The variables h and d are dropped since it is as-

r	1	2	3	4
A				

sumed that the cardboard possesses uniform thickness and density. Hence, in every case, the area of each circular disc can be determined from the ratio of its weight to the weight of the cardboard disc of unit area. These data may be presented to the class. The only explanation necessary to the class would be simple statements of this type: "If the unit of area weighs x grams and a circular disc of the same thickness and material weighs y grams, we can determine the area of the circle by dividing the weight of the disc by the weight of the unit disc. The quotient will be the number of units of area contained in the circle."

A simpler method would be that of using graph paper. Values are assigned to the large and small squares. Then after drawing a set of axes a set of concentric circles could be drawn. As each circle is drawn the squares of unit area are counted in the circle with appropriate estimates for the portions of squares.



The class probably will see the economy of counting units in a quadrant and multiplying by 4 after counting squares in the first one or two circles.

A study of the table will reveal a relation between the square of the radius and the area of the circle. "Lead" questions would be of this type: "Is there any relation between the radius and the corresponding area of circles? If we double the radius is there any relation? What other operations can we perform in an attempt to discover the relation between the radius and the area of the circle?"

This discussion should result in acceptance of a general statement and finally a tentative formula such as $A = kr^2$. k can be determined by substituting values for A and r in the equation and by averaging the values. From this work, the identicalness of k and Pi will be seen. The work of graphing and studying the characteristics of the parabola may proceed from here as in the study of the linear relation.

Data showing the relation of velocity to stopping distance ($D = .07v^2$) in cars could also be used to introduce work on the second degree equation or experiments showing either the relation between distance and time for freely falling bodies ($S = \frac{1}{2}gt^2$) or the relation between the period of a pendulum and its length, $t = 2\pi\sqrt{L/g}$ or $L = kt^2$.

VI. Evaluation[10]

The exercises which follow represent crude instruments which might be used (1) as a basis for class discussions and (2) as a beginning point for more refined evaluation instruments. The titles of the exercises should in every case be omitted when given to the pupils.

The graph on the following page represents the income of John, who sells newspapers for the *Daily Tattler*. According to the graph, he receives a basic salary of \$2.00 per week plus a commission of 1¢ per paper sold.

1. Suppose John's employer decides to raise his basic salary to \$3.00 per week giving him the same commission on the number of papers sold. Would a graph of John's new salary (using the same scale) be any different from the above graph? Yes ( ) No ( ).

If so, how? .....

.....

[10] In addition to the exercises the following references in Chapter XIII of *Mathematics in General Education* will be helpful in constructing evaluation instruments:

"Understanding of Some of the Qualities of Good Data," pp. 355–356.

"Understanding of Advantages and Disadvantages of Various Ways of Presenting Data," pp. 361–364.

"Drawing Inferences from Data," pp. 364–365.

"Ability to Apply Several General Principles of Variation," pp. 366–368.

"Interpretation of Data," pp. 375–378.

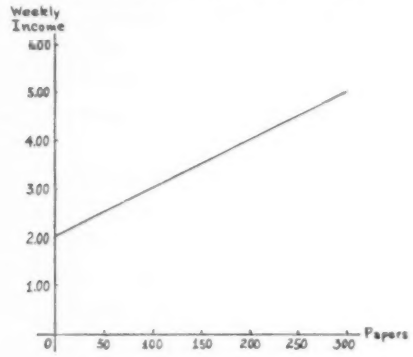
Where would the graph begin?.....

.....

2. Suppose his basic salary is not increased but he is given a commission of $1\frac{1}{2}¢$ per paper sold. Would a graph of John's salary based on this change (using the same scale) be any different from the graph shown? Yes ( ) No ( ).
If so, how?.....

.....

Relating Change in Slope to Change in Rate



3. Suppose John stops selling papers and gets a job delivering the monthly bills of the Electric Power Company to its customers. For this work the company will pay him a salary of $2.00 per week plus a commission of $1¢$ per bill delivered. Would a graph of John's salary on this job be any different from the above graph? Yes ( ) No ( ).

If so, how? .....

.....

4. Suppose his salary is doubled and his comimssion remains at $1¢$ per paper sold. Would a graph of this salary be any different from the original graph? Yes ( ) No ( ).

If so, how? .....

.....

Where would the graph begin? .....

.....

5. Suppose his salary is not increased but his commission is reduced to $\frac{1}{2}¢$ per paper sold. Would a graph of this salary be any different from the original graph? Yes ( ) No ( ).

If so, how? .....

.....

Where would the graph begin? .....

.....

Recognizing Necessity for Representative Sampling

A certain newspaper wants the general opinion of the citizens as to whether employees of the public utilities companies should be allowed to strike. The newspaper decides to make the survey by mailing out 2,000 post cards. Suppose that all the cards are mailed to the employees of the street car and bus companies. Would you consider this method suitable for obtaining the general opinion of the citizens? Yes ( ) No ( ).

Why? .....

.....

2. Suppose the cards mailed are limited to the subscribers of the newspaper. Is this method suitable for obtaining the general opinion of the citizens? Yes ( ) No ( ).

Why? .....

.....

3. Suppose the survey is made during the strike of the street car and bus employees of the Green Line, and to save money the newspaper decides to question all people walking the Ohio River bridge. Is this method suitable for obtaining the general opinion of the citizens? Yes ( ) No ( ).

4. How would you have decided to whom you would mail the cards?

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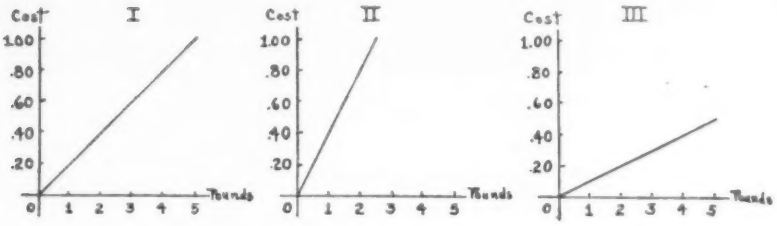
Relating Like Characteristics in Different Types of Data

The tables, graphs and formulas listed below give information on the cost of tomatoes per pound during different seasons of the year.

I		II		III	
No. of Pounds	Cost	No. of Pounds	Cost	No. of Pounds	Cost
0	\$0.00	0	\$0.00	0	\$0.00
1	.40	1	.10	1	.20
2	.80	2	.20	2	.40
3	1.20	3	.30	3	.60
4	1.60	4	.40	4	.80
5	2.00	5	.50	5	1.00
I		II		III	
$c = .20n$		$c = .10n$		$c = .40n$	

(c represents cost and n represents number of pounds.)

The price of tomatoes is determined by the season of the year. Suppose that the seasons are: (1) the growing (spring-summer) season, (2) the fall season and, (3) the winter season. Which graph corresponds to each season?



Graph I corresponds to season .....

Graph II corresponds to season .....

Graph III corresponds to season .....

What caused you to put the graphs and seasons together as you did?

.....

The information that one can secure from each of the graphs is the same as the information obtained from one of the formulas and one of the tables. Which formula corresponds to each graph?

Graph I corresponds to formula .....

Graph II corresponds to formula .....

Graph III corresponds to formula .....

What was in the data that caused you to put these formulas and graphs together as you did? .....

.....

Which table corresponds to each graph?

Graph I corresponds to table .....

Graph II corresponds to table .....

Graph III corresponds to table .....

What was in the data that caused you to put these graphs and tables together as you did? .....

.....

Which formula corresponds to each table?

Table I corresponds to formula .....

Table II corresponds to formula .....

Table III corresponds to formula .....

What was in the data that caused you to put these tables and formulas together as you did? .....

.....

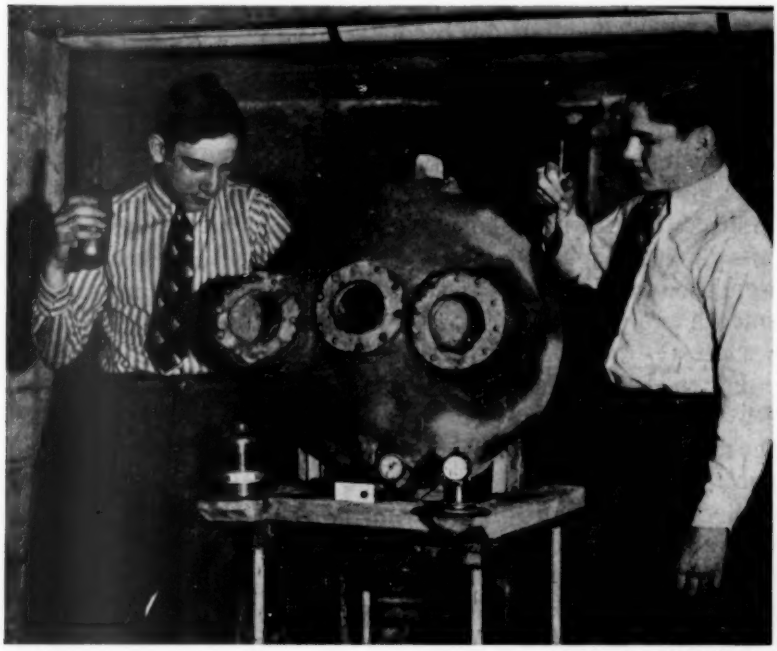
Note: This exercise might lead into a discussion of the relative merits of a group of straight line graphs on the same axis and the broken line graph for noting the total cost directly for any number of pounds of a commodity (up to a certain amount) for any season and for comparing the *rate* or cost per pound of the commodity at any *month or season* with *any other month or season.*

A MODEL BATHYSPHERE

MAITLAND P. SIMMONS
Irvington High School, Irvington, New Jersey

DETAILS FOR CONSTRUCTING MODEL

Below is a pictorial example with a detailed description of how these two tenth-grade biology[1] students actually made this out-of-school model of Dr. Beebe's Bathysphere.



Courtesy, *Newark Sunday Call*

HOWARD HERMAN (left) and WILLIAM WAGNER (right), Irvington High School, at work on their model of Dr. Beebe's Bathysphere.

The first step in its actual construction was to make a form consisting of five 24-inch wire circles. Four were joined together to resemble the meridians of a globe and the fifth formed the equator. With this as a foundation, six smaller circles were constructed and fastened in place to resemble the parallels on a globe. All joints were wired and soldered. For observation ports,

[1] Such a subject as biology lends itself readily to project treatment. From this leisure-time activity much has been gained by the pupils in learning and applying scientific knowledge with the coöperative effort of the parents. The bathysphere project has then served not only as an important educational function but as a means of motivating a friendly home and school relationship.

three 7-inch center openings (1 inch apart) were cut and stovepipes (center one, 2 inches long; side ones, 2 inches long on the inner side and 8 inches long on the outer side) fitted in the apertures. The outside tubes were slanted slightly toward the center. A fourth hole (7 inches) was made for the back hatch. The framework was covered with fine wire, sewed cheesecloth, and coarse asbestos; then fine asbestos to provide a smooth surface. Next, three 5-inch circular glass pieces were set between corrugated cardboard window frames. For the back door, a 4-inch circular piece of cardboard ($\frac{1}{2}$ inch thick) was cemented to the center of a 7-inch circular cardboard. To give a realistic effect for holding the windows and the all-cardboard hatch in place, ten hexagonal nuts were screwed on evenly-spaced stub bolts inserted in the frames. The windows and door were then fitted into position. Next, a $\frac{3}{4}$-inch hole was made slightly to the side of the top center of the ball and a heavy wire (telephone cable) was inserted. For the three-hole cable block, a 4 by $\frac{3}{4}$ by 2-inch piece was glued at the top center of the ball. Putty and plastic wood were used to fill in joints and contours. The ball was then sanded smooth and painted (two coats) a marine blue to give it a deep sea effect.

For the bathysphere's supports, two wooden pontoons (24 by 4 by 2 inches) were cut out and inclined slightly downward at the ends. A crossbar (14 by 4 by 2 inches) was then attached at a point 4 inches from each end. In the center of these four pieces, a 4 by 2-inch upright (upper inside inclined slightly downward) was bolted (two bolts). The diving chamber, now ready for exhibit, was set in between the props.

The final step was to install, through an already made side-observation window (10 inches square), equipment consisting of two genuine oxygen tanks (procured from a chemical company), barometer, ventilator, and radio instruments.

Obstacles and Outcomes

Progress was considerably hampered owing to unavailable plans and inadaquate facilities for construction. Due to this fact, six months were needed, working at odd hours, to finish the work. The cost of materials was approximately five dollars. The tools included whitewash brush, paint brush, screw driver, hammer, pliers, trowel, tinner's shears, soldering iron and saw.

During a general science display in our school library and at the American Institute Science and Engineering Fair, New

York City, this unusually large size model aroused considerable enthusiasm among students, parents, teachers, and friends. One of the boys who participated in its creation received a money-award for his most interesting description in the Science Fair issue of *Current Science*.[2]

From this leisure-time activity much has not only been gained in learning and applying scientific knowledge in a democratic spirit of coöperative effort, but the writer feels a deep personal satisfaction for his part in the service rendered. Project work should be a potent force towards making the family a stronger unit. The school at every point should take the home into consideration as a partner whose friendly relationship is not only desirable, but absolutely essential if the boy or girl expects to enjoy a more useful life. If the project serves as an important educational function for the science-interested adolescent, and it should, then science teaching affords an excellent opportunity for taking the school into the home.

[2] "Your Science Fair" *Current Science*, Vol. XXVI, No. 31 (April 21–25, 1941), p. 123.

ESTABLISHES DIVISION OF INTER-AMERICAN EDUCATIONAL RELATIONS

John W. Studebaker, U. S. Commissioner of Education, in a desire to promote closer relations between the American republics in the field of education today established a Division of Inter-American Educational Relations in the U. S. Office of Education.

Commissioner Studebaker designated John C. Patterson to head the Division. During the past year, Dr. Patterson has been U. S. Office of Education Senior Specialist in Higher Education relating to Latin America.

Activities of the U. S. Office of Education in this field include the exchange of professors, teachers, and students between the United States and the other American republics, in cooperation with the Department of State. It also provides for the preparation and distribution of materials in the inter-American field, the lending of materials on Latin America through its Information Exchange on Education and Defense, and the evaluation of credits and other assistance to students from schools and universities in the other republics by the Division of Comparative Education. Exhibits of teaching materials—books, maps, films, handicrafts, pictures, etc.,—in the inter-American field are also prepared by the Library Service Division. The U. S. Office of Education program also calls for the development of demonstration centers in inter-American education in a number of schools and colleges throughout the country.

The Office works in cooperation with the Department of State, the Office of the Coordinator of Inter-American Affairs, the Office of Foreign Agricultural Relations, Department of Agriculture, as well as with the Pan American Union, the National Education Association, the American Library Association, the American Junior Red Cross and other organizations interested in the inter-American field.

BIOLOGY GREENHOUSE TECHNIQUES AN AID TO YOUR NATIONAL DEFENSE PROGRAM

M. C. LICHTENWALTER
*Lane Technical High School, Chicago, Illinois**

Would you like to venture into some phase of national defense with your biology classes? No doubt you would. Everyone is becoming nationally minded. Since the declaration of war teachers are seeking ways and means of instilling patriotism of some form into their charges. Most recall hearing of the war gardens of and before 1918. They might have been rightly called biology war gardens but this was before the universal advent of biology into the secondary school curriculum. Let us hope there are many such gardens initiated this spring as well as other worthwhile community projects.

As an illustration some few weeks ago the writer received an invitation from the commanding officer of one of the United States Army Recreational Area Camps to initiate the beautification of a certain area of the camp as a school project. You may not all have a similar opportunity to show your patriotism but there are practical projects for community improvement you may carry through with your biology classes.

To initiate civilian defense in your community for the coming spring why not devote a few projects directed toward defense gardens with your biology classes. Since one use of the greenhouse is to give plants an early start in the spring this work may be started in your own greenhouse or the growing facilities available in your school. You may do an extensive or at least constructive piece of work for the community, relieving other agencies for an "all out" in other fields.

GREENHOUSE REGULATION

It is essential to maintain an even temperatured house. For most plants the day temperature should be in the high sixties and the night temperature in the high fifties. Avoid temperature extremes either hot or cold and sudden changes in temperature.

To maintain the proper temperature you must know how to operate the heat valves, the thermostat, and the heating plant. Place a thermometer near the controls at a convenient height and clearly indicate the desired day and night temperatures for

* N.B. The writer will gladly answer any inquiries relative to techniques mentioned in this paper or where materials may be purchased.

all to observe. If your greenhouse has a separate automatic heating plant you are fortunate. In case there is danger of not receiving a sufficient amount of heat or a constant supply your plant beds could be wired with electrical heating units.

Healthy plants need ventilation. Any fresh air admitted must be tempered to room temperature before it reaches your plants. Drafts, hot or cold, slows plant growth. When there is danger of frost; which in the Chicago area is from October fifteenth to May fifteenth; we never open the side ventilators. The top ventilators are used, being opened on the side opposite the direction of the prevailing wind; generally from the North. We do not ventilate at night when the outside temperature is in the forties and very little in the daytime.

Correct watering is essential. Watering maintains moisture for the root system and humidity for the plant foliage. Watering every other day is preferred to daily shallow waterings. The plant foliage may be syringed frequently with a fine spray. On cloudy days we do not water. Potted plants loose moisture through the sides of the pot. This may be corrected by placing the pots part way in a mixture of peat moss and humus. In this manner the pots may be subirrigated or watered from the top.

Equipment and Supplies

The outlay for equipment and supplies need not be extensive nor expensive. There should be a variety of clay pots. The two and three inch sizes are most frequently used. Several of the other sizes should be available. For growing seedlings you will need several germination boxes or seed flats. A desirable size is twelve by eighteen by three inches. Your students may construct these from discarded orange crates. They should be uniform in size to store easily. Your tools will include trowel, shovel, sieve, and dibbler. Watering equipment should include hose, nozzle and a few shallow pans to subirrigate seed flats. There should be a sprayer and several good sprays for insects and disease. In the work room there should be a potting table and bins for storage of supplies. There should be racks in the greenhouse for placing seeded flats.

Soil Conditioning

Due to artificial conditions present in greenhouses plants demand a variety of different soil mixtures. Some of the soil separates needed for soil mixing are good loam soil, sharp coarse

sand, peat moss, manure dried and pulverized, humus and commercial fertilizer. The loam is used in most all soil mixtures, while the sand is used in the propagation bed for rooting cuttings and in the soil mixture for growing seedlings. Peat moss makes the loam loose and porous but is only a soil conditioner and not a fertilizer. Manure in addition to being used as a fertilizer is also a good soil conditioner. The manure can also be used to make liquid manure by pouring water over a quantity of the material in a metal container and stirring the material occasionally. After a few hours the liquid may be poured off and applied directly to the plants needing the material.

Desirable Soil Mixtures

It has already been pointed out that potted plants may be kept from drying out so rapidly by placing them in a mixture of humus and peat moss. This mixture has high retention qualities for water. For the propagation bed mix three parts sand and one part peat moss. Keep this mixture damp. The peat moss may be omitted if it is desired. Soil mixture for general potting and for bench work is made of one part sand, one part peat moss, three parts loam, and one fourth part manure or a smaller part of fertilizer. In the event you do not have peat moss for soil mixtures the product of the compost heap may be substituted. Soil for winter use should be secured in the fall before the ground freezes. A sufficient amount should be stored for the winter months.

Growing Plants from Seeds

Plants of vegetables and annual flowers may be started in the greenhouse any time after February. Your perennials may be started after these annuals are moved to the hot bed but it is better to start them in the fall and winter them over in cold frames. Your cold frame is your hot bed without artificial heat. Briefly the process for growing plants from seed is to sow the seed in flats. When the second set of leaves appear each plant is pricked out or transplanted into another box. Space the plants about an inch apart. Later if the plants crowd each other they may be shifted to pots or into other flats. They should grow slow and develop a strong root system. This is accomplished by keeping the plants at a cool temperature, the minimum amount of moisture and not too rich a soil mixture for the root structure.

Excessive temperatures, moisture and plant food make weak shallow rooted plants.

The size of the seed flat has already been mentioned. The soil for seed germination should not be too rich as the seedlings will grow rank and the spindling plants will not stand the shock of transplanting. The soil mixture should be loose and porous to permit root growth. A satisfactory mixture is one part sand, one part peat moss, and two parts loam. The flat should be filled up to within one-half inch of the top with the mixture. A thin layer of sand should be spread over the surface of the soil. Sow the seed in rows and soak the flat in a pan of water but do not flood the top of the soil. The flat is then covered with a glass to retain the moisture and protect the sprouting seedlings. It may be removed when the seedlings are up. Keep the soil moist but not soaked.

The soil mixture for the plants which have been pricked out may have some fertilizer added and a little less sand. This mixture may be used until the seedlings are ready to be set out in the garden after danger of frost is past in the spring.

Making Slips or Cuttings

You perhaps have observed your mother taking a slip from a plant and placing it in a glass of water. After roots were formed she would plant this slip or cutting in a pot of soil. You may employ the same process in propagation of plants by using moist sand in place of water. You may easily make cuttings from geraniums, coleus, begonia, peperomia, sedum, philodendron, Chinese evergreen or Vinca minor. The list is suggestive as the variety of plants that may be so propagated is nearly unlimited.

You will want to reserve a section of your greenhouse bench for a propagation bed. This should be filled with five or six inches of sand or sand and peat moss. The bed should be watered well, then you are ready to make cuttings. Cuttings should be made from the new growth of the plant you desire to take cuttings. About a third of the stem of the cuttings should be placed in the sand the remaining leafy portion should be left above. They should root in from three to five weeks. Stimulants for root growth may be used and there are several good commercial products available. It will reduce the rooting time several days to a week. After the plants are formed the plant is potted and treated the same as any other plant.

Some plants require special care. Sansaveria must be cut into three-inch-long sections of its leaf. These are buried about two inches in the sand and watered. Water is then withheld from the cutting to induce root growth. Geraniums should not be watered too freely as they will absorb moisture and grow but will not form roots. Excessive watering of geraniums also induces rot in the stem. Poinsettias are started in June by growing them in a sweat box. A sweat box is a bottomless box with a glass cover. This is placed over the cuttings. It conserves moisture and prevents drafts from injuring the plants until they are rooted.

Insect Pests and Control

Plant pests encountered in the greenhouse includes the red spider, aphid, mealy bug, white fly, scale insects and a few others. You will never be entirely free from pests as you are constantly receiving plants to care for over vacations which are quite frequently infested with them. You should learn to identify the insects and know on what part and what type of plant they may be found. If eating or sucking insects are present a stomach poison must be used. In other cases a contact insecticide may be employed. If there are several kinds of insects present or suspected two or more spray materials may be needed. These may be compounded and applied simultaneously. The best method of control is prevention. Good prevention is routine spraying every ten days to two weeks. Applications as frequent as this will reach each generation and keep the insect population at a minimum.

Commercial spray mixtures generally contain either rotenone root, pyrethrum powder, a nicotine compound or oil emulsion. Each are effective and have a particular reaction. Most sprays on the market are compounded to eliminate certain insects. Examine the formula of the spray before buying it. Follow directions as to application and concentrations. A constant pressure tank sprayer is most effective.

Some facts for you to remember are that weak legged red spiders may be washed from their seat of action by a firm spray of clear water. Also that cultivation and steam sterilization of soils will destroy most insects and their eggs. Sow bugs attack the roots of seedlings and do considerable damage to the plants. They may be killed by fumigation which will also kill insects and mice if they are present. Mealy bugs have a downy covering

over their bodies and egg masses. A spray of low surface tension may be used to penetrate this structure.

Some diseases encountered are rusts, crown rot, root rots in variety, and fungus. They may be combatted with mixtures containing lime, sulphur, or copper sulphate. "Damping off" of seedlings may be prevented by keeping the surface of the soil fairly dry. There are compounds to apply to counteract this on the market.

Suggested Biology Projects

Growing Plant Seedlings: In March sow vegetable or flower seeds. Include the better varieties of such vegetables as tomatoes frost proof cabbage and cauliflower, and peppers; or flower varieties such as zinnias, petunias, ageratum and alyssum. They may be sown in germination boxes and when they are pricked out into flats they may be carried through in these until time to plant them in the spring garden.

A Biology Garden: Use your seedlings raised in your plant seedlings project. Prepare a good seed bed. Place the plants deep in the soil and firm the earth about the roots. Water well and shade for a day or two or set out in the evening, or after a rain, or in a cloudy day. The vegetable may be disposed of to needy families through proper channels.

Campus Beautification: Duplicate the Biology Garden project idea on a larger scale. Select several areas on the school campus that could be improved with flower beds. These may be located in unused areas, near buildings, where walks converge, near fences or other desirable locations.

Building Improvement: Use your greenhouse as a reservoir for potted plants. These may be moved out at intervals to be placed in window boxes for class room, hall or stairway, or potted plants for teachers' desks and special rooms. They should be tended regularily and replaced at intervals.

Flower Show: This is an excellent manner to sell biology to the student body and make them conscious of the efforts of the department. Why not a layout of a number of types of gardens showing biology war garden lay outs?

Experimentation: There are a number of experiments that might be mentioned. Vitamins for transplanting—for root growth; hormones; albino corn for Mendel's ratio; soilless plant growth are some experiments to be tried.

The Factor "X" in Your Schedule

If you are going to care for the greenhouse why not do a constructive job? A clean greenhouse will grow healthy plants free from disease and cleanliness is an important factor in its success. Wheel out the exhausted soils in your benches get rid of the enormous accumulation of dead and sickly plants rushed to you from a number of teachers' rooms the day before a holiday for keeping and never again called for. Soak the dirty pots for a day in a bucket of water and have some student wash them. After they drain sort them and store them in suitable convenient places for use again. Provide storage bins or receptacles for your soil separates. Obtain fresh living materials or seeds and begin your projects. In the meantime inform your immediate superior that you must have some extra time for this work. Outline to him what you wish to accomplish and get him to look over your work. Ask him to relieve you from some of the added duties including corridor duty, study hall, club work, noon supervision, or whatever is your lot. Your work will be just as valuable to the school and constructive in the national emergency.

NUTRITION EDUCATION IN EVERY SCHOOL— IN EVERY COMMUNITY

Just issued by the U. S. Office of Education in its Education-and-National Defense Pamphlet Series is "Food for Thought—the School's Responsibility in Nutrition Education."

"The major casualities of any national crisis or war are never to be found in the lists of soldiers and sailors wounded and dead—but in a sickly, starving population" the bulletin points out. "A nation in crisis needs food in quantity, quality, and balanced proportions to preserve the faith of its people and to maintain national unity, morale, efficiency, and fighting strength."

The U. S. Office of Education publication reports on our national and nutritional status and suggests how schools and communities can provide nutrition education and services.

One chart in the pamphlet identifies characteristics of malnutrition and undernourishment in children. Others show causes of malnutrition and vitamin foods essential to good health.

Copies of "Food For Thought—The School's Responsibility in Nutrition Education," are available from the Superintendent of Documents, Washington, D. C., single copies 15 cents.

FIRE RESISTING TEXTILES

Fire resisting textiles can be made by treating cloth with ammonium sulphamate. This chemical, once a laboratory curiosity, is now in mass production for war purposes. Cloth treated with the chemical will char in flames but will not blaze and will therefore not spread the fire.

DEVELOPMENTS IN EXPLORING LITHOSPHERE AND ATMOSPHERE[1]

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In earth science the greatest advantures were those concerned with the exploration of the surface of our planet. The centuries between the fifteenth and the nineteenth are packed with the thrilling exploits of daring men but it seems that the present century has brought this era to a close. Little unknown territory remains on the surface of the earth. Yet when the last frontiers seem to be reached new vistas of unexplored regions appear. In scientific history the current century will once probably become known as the one that opened the third dimension on the earth. The exploration of this third dimension is perhaps less romantic than expeditions to jungles and ice-fields but for the advancement of knowledge it is of equal importance. The methods of exploration are also less direct, yet not less revealing and probably more ingenious. The science of geophysics is trying to unravel the mysteries of the third dimension on the earth. It attempts to look into the interior of the earth as well as to fathom ebb and flow in the earth's ever-changing atmosphere. In both endeavors the last two decades have seen striking developments. As in all other sciences the knowledge gained has proven to be of eminent practical value. What has been learned about the solid earth helped in locating natural resources through the geophysical methods of prospecting and what the studies of the atmosphere have revealed is to-day an indispensable aid in aviation. As time goes on the terrestrial third dimension will become as much the domain of mankind as the surface has been for centuries past.

THE LITHOSPHERE

Most prominent in helping us to visualize the status of the interior of the earth have been seismological studies. Waves produced by natural or artificial earthquakes undergo a history when travelling through the earth after leaving the focus of the disturbance. They arrive and are picked up at seismograph stations and the composite of the intricate patterns recorded at each observatory tells a tale of interior structure. The elastic

[1] Contribution Number 3 from the Institute of Meteorology, University of Chicago. Read at the Physics Section, Central Association of Science and Mathematics Teachers, Nov. 21, 1941.

waves are subjected to the well-known phenomena of refraction, reflection and absorption. These influences affect the amplitudes of the waves and the times for their travel from the center of the disturbance to the recording station. If the travel-time to the stations is known as a function of distance from the focus one can calculate the speed of the waves at any depth. This speed in turn is a function of the density and the elastic constants of the material through which the waves have travelled. Changes in these constants are more or less definitely expressed in the depth-velocity curves. For the surface-near portions of the earth's crust an innumerable variety of layers has been discovered, corresponding to the complicated picture of geological

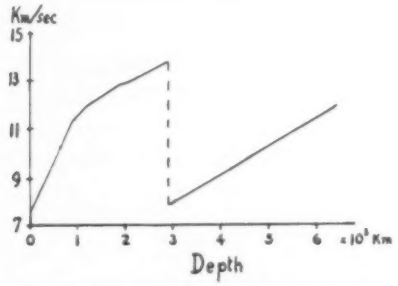

FIG. 1. Change of velocity of longitudinal waves with depth in the interior of the earth.

structure. Extensive use of this fact has been made to obtain information on the hidden features of the crustal zones in connection with mineral deposits. Even for greater depths, down to perhaps 50–100 kilometers, considerable differences in the encountered types and numbers of layers exist in various parts of the earth. Below these levels a more homogeneous picture is apparent. The earth shows a number of concentric shells around a core. This becomes evident from the depth—wave-velocity curve shown for longitudinal waves in figure 1. The curve shows in the first 2900 kilometers a number of changes in slope, each indicating a more or less sharply defined boundary. At about 2900 kilometers depth a major discontinuity is evident. Here the core starts with a number of major changes in properties, especially a drop in rigidity that suggests a change in the state of aggregation. In the higher portions one rather definite change is indicated at about 950 kilometers depth, with a series of minor changes at about 1200, 1900 and 2100 kilometers. The conclu-

sion is therefore that the earth has a crust of less than 100 kilometers thickness, a mantle of about 900 kilometers thickness, followed by several not too strongly differentiated intermediate shells of a total thickness of 2000 kilometers. From roughly 3000 kilometers downward extends a fairly uniform core. It is interesting to note that by an entirely different approach geochemists have predicted that from a once molten state of the earth the various elements should separate into four major layers. Analogous to the processes observed in a blast furnace with the slag forming on top of the iron melt the geochemical analysis postulates for the earth a metallic core, a layer of metallic sulfides and

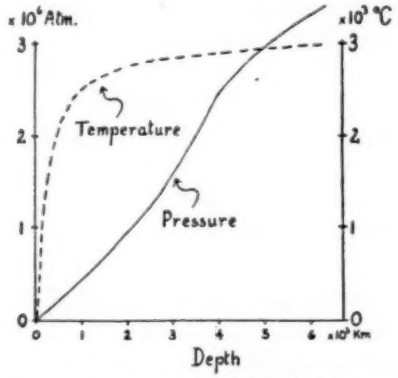

FIG. 2. Change in pressure (solid line) and temperature (broken line) in the interior of the earth.

oxides, a layer of glassy silicates and finally an outer skin of crystalline silicates.

While it was stated above that the sharp discontinuity in wave velocities at the core suggests a change in physical state it is difficult to visualize the exact nature of the core. A look at some other properties will lead to a better appreciation of this statement. Temperature and pressure increase with depth. For the pressure there is general agreement on the values reached in the core; for the temperature a number of possible interpretations of the known facts about heat loss, heat conductivity, heat production by radioactive substances present themselves. Figure 2 shows two curves, one representing pressure increase with depth, the other a compromise solution for the temperature increase as gathered from various authorities. We see that the pressures in the core are in excess of three million atmospheres

while the temperature is around 3000 degrees Centigrade. The temperature estimates have been revised downward in the last two decades. While some investigators always stuck to the lower values, at times opinions prevailed that estimated the temperature two or three times higher than the above given value. The behavior of matter at temperatures of several thousand degrees under normal pressure is well known from the laboratory. But what will happen under pressures of several million atmospheres? The question has to remain unanswered because high-pressures reached in the laboratory at present still remain two orders of magnitude below the ones in the core of the earth. No extrapolation of known states of aggregation is warranted under these circumstances and so the question mark has to be removed by future research.

The Atmosphere

The importance of weather and weather forecasting is commonplace. Improvements in the technique of forecasting in the last two decades have been intimately tied to the exploration of the upper atmosphere. In this country up to the first part of last decade weather forecasts were almost exclusively based on surface weather maps and the use of upper-air data only slowly infiltrated from European countries and research laboratories into the daily weather service. The United States has now by far the best network of aerological stations exclusively devoted to give information about the third dimension in the atmosphere. The technique of using sounding balloons with recording instruments attached to them dates back to the early part of this century. The equipment was sent aloft with a free balloon and, sometimes after weeks or months, was accidentally recovered. In many cases the records were lost. Of course, no use could be made for every-day practice of the information thus gained. Yet even at this early stage of upper-air exploration one most important discovery was made, namely the stratosphere. As is now well known, the temperature in the atmosphere decreases in more or less regular fashion with altitude in the lower layer of the atmosphere, called troposphere. Above this it changes into an approximately isothermal layer, called the stratosphere. The boundary between troposphere and stratosphere is called the tropopause. The height of the tropopause is variable in time and space. It is higher at the equator (about 16 kilometers) than at the poles (about 7 kilometers). For a fixed place its mean height is greater in summer than in winter, although fairly rapid fluc-

tuations from day to day take place. The mutual influence between the high atmospheric layers and the surface-near layers is a subject of investigations. Most interesting from a practical point of view are influences upon the daily weather.

As the demands of daily forecasting for information could not be fulfilled by the sounding balloon technique, kite ascents were made at a number of stations to supplement surface weather information. Kites are difficult to handle and the ceilings reached by this device are generally too low to fill the needs of the forecaster. After the war of 1914–18 airplanes were regularly employed to secure the information. Their ceiling was ordinarily limited to five kilometers and in bad weather, just when the information was most desired, they stayed grounded. Then, after a long experimental period the airplane was finally replaced by an automatic radio instrument that transmitted the information during the flight. Coupled with the experience gained in instrument construction during the days of the sounding balloon were the newest developments of radio transmitting and receiving technique. The modern "radiosonde" weighs not more than two pounds and contains in a cardboard box of less than a foot length in its largest dimension, barometer, thermometer, hygrometer, radio transmitter and the batteries necessary for operation. An added advantage to all previous methods is that the data are in the hands of the observer long before the flight is ended. The introduction of the radiosonde into daily use at over thirty stations in the United States marked a revolution in aerological history. Upper-air data are now a practical reality. Where once the surface weather map was the exclusive tool of forecasting technique we now find vertical cross sections through the atmosphere and horizontal sections representing higher levels. Charts for the 3-kilometer level are in current use at all forecasting centers. Levels up to 16 kilometers height are at present being tested for their significance for surface weather. Among the interesting facts is a relatively greater persistence of upper pressure systems (generally known as "Highs" and "Lows" from the surface weather maps) compared to the rapid changes in the surface layers. The general patterns of flow in the atmosphere are also better discernible from maps depicting the situation at levels of about 3 kilometers height. New theoretical concepts have shed light on the calculation of displacements on the more generalized pressure systems shown on upper-air charts.

Still another consideration will make it apparent why the

higher layers of the atmosphere have to be considered in conjunction with surface weather maps. Let the drawing in figure 3 represent the available upper temperature observations in a cross section from the pole to the equator along a meridian. The left portion represents summer conditions, the right winter conditions on the northern hemisphere. The dashed lines representing isotherms, are plotted versus the so-called geopotential or dynamic height. Geometric height and dynamic height are related through the gravitational potential and hence on a line

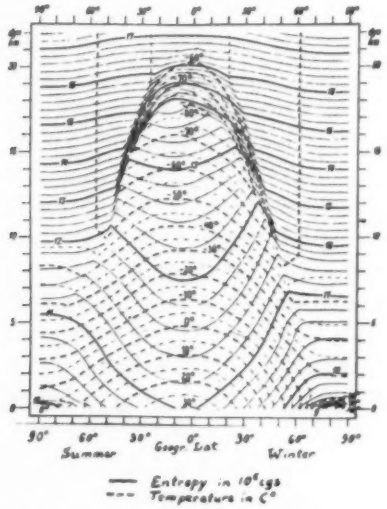

FIG. 3. Vertical cross-section through the atmosphere with temperature-entropy solenoids.

of equal dynamic height no lateral components of gravity exist. By choice of units a dynamic kilometer is only little different from the numerical value of a geometric kilometer so that for qualitative purposes the dynamic kilometers marked in the diagram can be interpreted as heights. Strictly speaking, however, the geopotential is an energy per unit mass. Also plotted in the diagram are solid lines representing levels of equal entropy. Since the lines in the cross section stand for surfaces of equal temperature and surfaces of equal entropy in the atmosphere they are representing solenoids. These solenoids indicate the circulation energy that is available from a given distribution of masses in the atmosphere. The denser the distribution of solenoids per unit area in the section the higher the available circu-

lation energy. It is immediately obvious from the cross section that the largest number of intersections between temperature and entropy lines is between 30 and 60 degrees latitude in high levels of the atmosphere. The level corresponds to the tropopause or in other words to the boundary between the troposphere with its temperature decrease with altitude and the stratosphere where isothermal conditions prevail. The higher circulation energy present in these layers is expressed in higher wind velocities resulting in drag on the lower layers and also in pressure difference fields that influence the fields of motion in the lower atmosphere. This, in brief, is another reason why meteorological science has to use upper-air data for a more complete understanding of weather phenomena.

Many questions about the atmospheric "heat engine" remain unanswered. The conversion of radiant solar energy into the kinetic energy of storms is a complicated process. Possibly layers even higher than the levels now commonly reached by our sounding balloons contribute to the cycle, which operates most intensively in the surface layers. There probably the major energy transforming processes take place, yet the complete mechanism remains unsolved. And so in meteorology, too, the doors remain wide open for the pioneer explorer.

USE OF THE BULLETIN BOARD IN THE CHEMISTRY CLASSROOM

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Reference is occasionally made in this journal to the use of the bulletin board in chemistry classes. Too often the bulletin board material is not examined by all pupils, or is seen by many after the class has passed the textbook material to which the bulletin relates. Thus it loses effectiveness as a teaching device.

If bulletin board material is useful it should be seen by all pupils in the class. The writer has for some time used a different method for bringing before his pupils such pictures, graphs, diagrams, tables, maps, etc., as may be found and brought in by teacher or pupil. The practice is to paste the picture, etc., on a piece of cardboard and then pass it around for pupils to examine while at their seats.

The system has the advantages that several items can be examined by each pupil in a few minutes time without the confusion of having everyone going to the bulletin board. In addition, the item is used while it is pertinent to the subject matter being discussed. The mounted material may be filed by unit or chapter and used the following year.

NOTES FROM A MATHEMATICS CLASSROOM

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1. Introduction. During twenty-nine years of teaching mathematics (four at the University of Wisconsin, one at Princeton University, and twenty-four at Hyde Park High School) I have collected a great many notes about teaching. Some are scribbled in the margins of books, some are in files, and some in envelopes. Some have imposing titles, and some seem so trivial that I wonder why they were written. Many of the notes have been used as material for articles, but others are merely brief remarks about an exercise, a simple way of introducing a concept, or a helpful mnemonic. Doubtless most of them are the result of experiences that come to all teachers and can hardly be original. However, the editors of SCHOOL SCIENCE AND MATHEMATICS have agreed to let me put some of the ideas into print. Hence each month until my files are empty or the readers lose interest I shall present a few.

2. The Signs of the Trigonometric Functions. During the first World War every school had an S.A.T.C., the Student Army Training Corps, the predecessor of the present R.O.T.C. If the letters are arranged in the form $\begin{array}{c|c} S & A \\ \hline T & C \end{array}$ with lines to separate them so as to suggest the four quadrants, we have a simple way of remembering the signs of the trigonometric functions in the quadrants. The letter A stands for *All*, meaning that all the functions are positive in the first quadrant. S is for *Sine;* it and its reciprocal are the only positive functions in the second quadrant. Likewise, T is Tangent, and C for Cosine.

3. Use of the Words "Given" and "Prove." The usual presentation of a theorem in a geometry text consists in stating the theorem, showing a figure, and then printing in full-face type the words Given (followed by the facts for the particular figure) and Prove or To Prove (followed by the conclusion). Hence, when the theorem, for example, reads If $a=b$, then $c=d$, the pupil feels that he must establish the truth of the item $c=d$.

The new texts emphasize the if-then nature of theorems. We are not trying to prove that $c=d$; we are trying to prove the

entire statement: if $a=b$ then $c=d$. It is difficult to make the pupil appreciate this as long as the text says "prove $c=d$." My suggestion is that the texts change some of the terminology. In place of saying

Given: $a=b$ Prove $c=d$

let us say

Hypothesis: $a=b$ Conclusion: $c=d$

Looking through the texts on my shelves I find that this scheme was used in Rolland R. Smith's *Beginner's Geometry* (1927, MacMillan Co.) and in the Sykes-Comstock-Austin Geometries (1918 and 1932, Rand McNally Co.).

Since the word prove really means *test* we can argue that we are proving $c=d$ because we are testing this item to see if it follows from $a=b$. In one class I once tried the experiment of never using the word prove, saying instead "test this conclusion." But the influence on the class was slight; the pupils continued to say prove.

4. Basic Ideas about Proportions. It is nothing new to have a science teacher complain that pupils know little about mathematics when they reach a science class. A teacher of physics told me the story of a pupil who objected to the use of proportions in a certain problem. "How," said the pupil, "can you have a proportion when there are no similar triangles in the problem? There's no triangles at all in that problem." The pupil also thinks that the word proportion can be used only when dealing with *four* quantities so that he may have two numerators and two denominators. Hence he is confused when he hears about *two* proportional quantities.

Some work on proportions should be included in all ninth grade work, whether it is a course in algebra or in general mathematics. And the work should emphasize, not the computational aspects, but how we use the word *proportion* to express a certain type of relationship, namely:

(a) Two variable quantities are proportional if the ratio of any two values of one equals the ratio of the corresponding values of the other quantity, and conversely;

(b) Two variable quantities are proportional if any value of one of them is a fixed constant times the corresponding value of the other, and conversely.

Instead of emphasizing these relations, the work too often consists in solving problems by using proportions. In most cases

the pupil could solve the problems without any conscious use of proportions.

In the geometry class, the ninth grade work on proportions should be repeated. I also ask each pupil to start a collection of sentences in which the word proportion is used. The sentences may be from magazines, newspapers, or books read in other classes. Certain sentences from *Silas Marner* and *Julius Caesar* are turned in every year. To prove that he understands the quantitative relations in the sentence, the pupil must supply some numbers, either actual ones or fictitious. Thus, "Although Britain lost more material ships in the Battle of Jutland, their loss was less than Germany's in proportion to their respective navies." (Elson's *Modern History*).

Britain's loss: 2,000,000 tons; Britain's navy: 50,000,000 tons. Germany's loss: 1,500,00 tons; Germany's navy: 10,000,000 tons.

2/50 is less than 1.5/10

"The price should be in proportion to the number of vitamins supplied." (*Ladies Home Journal*).

If tomatoes costing 10 cents supply 300 vitamins, then oranges costing 25 cents should supply 750 vitamins.

Each pupil is required to collect a few examples in which it is necessary to supply or invent units for measuring the variables. Thus, the statement "Eloquence may exist without a proportionate degree of wisdom" requires the invention of some units for measuring eloquence and wisdom. Then 5 units of eloquence and 10 of wisdom would correspond to 6 units of eloquence and 12 of wisdom. To measure wisdom the pupil suggested that the speaker's I.Q. be used; to measure eloquence, use the average number of words spoken in a day.

The pupil should be given two or three weeks to make his collection and he should be warned that not all sentences using the word proportion will be suitable. Thus, "The man lost a large proportion of his goods in the fire" will not do, since proportion is here used to mean *a part of*.

5. Understanding the Terms in an Equation. Often a pupil's trouble with verbal problems in an algebra class is that he writes an equation without having clearly in mind exactly what his letter x represents. Even when the teacher insists that a solution must begin by telling what the letter represents, the pupil writes such statements as c=corn, or n=nickels. Only the strict disciplinarian succeeds in making the pupil write c=the

number of bushels of corn. Each year I begin by insisting on "the number of," and each year I submit to defeat. But on one point I dislike to compromise: the pupil must, whenever possible, state the unit of measurement. Thus, c = bushels of corn; y = age in years, w = weight in pounds.

After the equation has been written I like to have the pupil explain the meaning of each term in it. For example, if the equation is $90c+60(80-c)=72\times 80$ a perfect pupil would say:

"c is bushels of corn; 90 is the price per bushel in cents; the term $90c$ is cents, the cost of the corn.

$80-c$ is bushels of oats; 60 is the price per bushel in cents; $60(80-c)$ is cents, the cost of the oats.

72 is cents; 80 is bushels; and 72×80 is cents, the cost of the mixture."

The important idea is that each term of the equation is a number of the same units. If one term were dollars and another term were bushels, then the equation would be wrong. In an equation like $.06x+.05(4000-x)=230$ the first term represents dollars of income on an investment; hence each term must represent dollars. Of course it is possible to make an artificial problem in which the number of bushels of corn would be added to the number of square feet in an area, but the pupil would recognize such as puzzles.

6. Converse of a Definition. Each year I have in one of my classes an apprentice teacher—a student from the University of Chicago who is taking a course there in the teaching of mathematics and uses my class for practice. Sometimes I can catch him on simple but annoying questions.

For example, why do we insist that the converse of a definition be true? It is no answer to say merely that if the converse were not true the statement would not be suitable for a definition. Why would it not be suitable? Thus, what is wrong with defining a parallelogram as a quadrilateral that can be divided by a diagonal into two congruent triangles? According to this definition some parallelograms would have opposite sides parallel and some would not. But that is not different from the present situation in which some parallelograms have equal diagonals and some do not. The student who has had a course in logic can answer immediately. If geometry teachers are going to use geometry to teach logical thinking, I suggest that a course in logic be made a requirement for any teaching certificate.

A UNIT ON ACIDS FOR THE ELEMENTARY SCHOOL

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AND
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Ever since the early days of Nature Study, science educators have believed that some study of chemistry is desirable in the elementary school. We find that the earliest study suggestions call for work with candles, fermentation and the like. For a time, emphasis upon biological science resulted in the elimination of chemistry from many programs, but in late years the study of chemistry has been reinstated. Some outlines include entire units upon this subject.

The inclusion of some of these recent units on chemistry would be much more commendable had the science educators done other than dilute a high school chemistry course for the grades. One cannot see what place the formal study of "solids, liquids, gases and gels," or of "elements, compounds and mixtures" has in the elementary school program. Neither can one see why elementary pupils should work with the electrolysis of water, with the preparation of calcium sulfide or with the oxidation of magnesium.

It seemed to the writers that units more in keeping with the philosophies of the elementary school are possible. Accordingly a unit dealing with some of the common acids of the home was developed for the fifth grade of the Cortland Normal Training School. It supplements the State Course of Study in Science for the grade.

It will be noticed that the term "acid" is not introduced at the beginning of the unit. Pupils often think of acids as being substances that "eat" or "burn" and these preconceived notions might easily affect their observations. It seems desirable that pupils discover first some of the common properties of acids before they use the term.

The first planned experience is with vinegar and baking soda.* Acting on suggestions from the teacher, or on suggestions from

* The specific teaching procedures are also described in the *Cornell Rural School Leaflet*, vol. 35, no. 1, for September, 1941.

other pupils, one pupil mixes vinegar and baking soda in a tumbler. This demonstration pleases pupils and they usually plan to carry out the same procedure at home.

Other activites involving vinegar and baking soda follow. The pupils discover that a match will not burn in a dish in which vinegar and baking soda are effervescing. They learn that a candle in a jar will be extinguished when a little vinegar and baking soda are put in the bottom. When a thumb is held on the mouth of a bottle they hear the sound of escaping gas. They see that a cork can be blown from a bottle in which vinegar and baking soda are effervescing.

The next planned experience, following an interval during which home experimentation is encouraged, introduces lemon juice to the above substances. Mixed with vinegar, there is no reaction; mixed with baking soda, the lemon juice provides a spectacular reaction. The pupils summarize their observations by stating that both vinegar and lemon juice react with baking soda.

Cream of tartar is then introduced. The pupils discover by experimentation that cream of tartar will not react with vinegar, with lemon juice, or with dry baking soda. Upon consideration, they realize that in the last named mixture there is no water. When they add water and see the resulting reaction they are well on the way to realization of an important chemical principle, that water is necessary in many reactions.

Some pupils may question the last experiment by suggesting that the baking soda or the cream of tartar will react with water alone. Such a critical attitude should be one of the foremost goals of science education. Pupils exhibiting a critical attitude need encouragement. In case no pupils make the suggestion, it might be considered advisable to use leading questions to bring about the criticism. The reaction can be tested simply enough by dissolving soda and cream of tartar separately and then pouring the solutions together.

Up to this point the work has been one of experimentation and observation. Generalizations have been avoided. It is now possible, however, to call for a few tentative hypotheses upon which to base further experimentation. By reference to taste, pupils recall that both vinegar and lemon juice are sour. A solution of cream of tartar in water, sipped through straws, or a pinch of the powder on the tongue, discloses that cream of tartar, too, is sour. Here are three substances, all of them sour, and all

reacting with baking soda. Are there other sour substances, which will react with baking soda?

Home experimentation, plus some work in class, reveals that a number of sour substances, sour milk and many fruit juices such as orange and tomato juice, will react with baking soda. Some substances which are not sour, such as sugar, salt and starch, will not react.

The term "acid" can now be introduced to encourage further experimentation. It is explained that scientists label as "acids" those sour-tasting substances which react with baking soda. Some substances commonly known as acids can be tested. Boric acid and oxalic acid, both common in the home, will react with baking soda. Sulfuric acid, known as "battery acid" reacts vigorously. Hydrochloric acid, sometimes called "muriatic acid," and used in soldering or for studying rocks, is often available, and can also be tested.

A good summarization activity for the pupils is the collection and exhibition of acid-containing substances or their pictures. A record of the discoveries for the individual or class notebooks can consist of labels from cans and pictures of substances containing acids.

The unit has much to recommend it. No complicated apparatus is required and no strange chemicals are involved. Emphasis is placed on direct observation rather than upon reading and pictures. Instead of beginning with a generalization as so many units do, generalizations are made only after a background of experience has been established. In addition, there is ample opportunity for pupils to criticize each other's suggestions and work.

The unit leads naturally into a study of the soda-acid fire extinguisher, the study of carbon dioxide and the study of quick-bread making. A similar unit on the alkalies is possible. It is not recommended that such units follow immediately after the unit on acids—some might well be deferred to higher grades.

Not least among the advantages of this unit is the encouragement of home experimentation. A great deal needs to be done with making school science carry over into the out-of-school life of pupils At Cortland, a record of pupil reports on home experiments forms interesting testimony of the success of the unit in this respect.

WHAT SCIENCE ARTICLES DO JUNIOR HIGH SCHOOL PUPILS READ?

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"Radium, which was present when the earth was formed, helped to melt great masses of rock," read the science teacher to her seventh grade class. Immediately, 11-year-old Robert raised his hand. "A boy of sixteen has just invented a substance which is stronger and cheaper than radium," he said. Both class and teacher questioned his statement but he proved later that he had spoken correctly by orally reading the article from a popular magazine. Whether or not the particular article he quoted was accurate is beside the point. What *is* important to science teachers is the fact that most junior and senior high school pupils these days are getting a considerable amount of science information from more or less reliable magazine articles.

Such reading is distinctly valuable to teen-age boys and girls providing that they realize the importance of the right attitude of mind in their acceptance of the scientific information contained in the article. They should learn to consider such questions as, "Who wrote the article? What is his scientific background? What is the reputation of the magazine?"

Such an attitude of thought probably can best be built up in the science classroom during frequent periods of free discussion of magazine articles. These discussions may vary from a few minutes to a full class period, depending upon the subject matter of the article and upon the daily scheduling of regular class work. A "Current Science Day" every three or four weeks has proved its value at the Stewart Training School of the University of Utah. Each member of the junior high school science classes comes to class prepared to speak for two minutes or less on a recent science article of his own choosing. He gives the title of the article, date and name of the magazine, and then a synopsis of the article, illustrated with photographs or diagrams. He is then open to questioning by members of the class. This often leads to a lively discussion which is frequently of greater value than the material of the original article.

Because these Current Science Days seemed so popular and because the pupil reference in regular class work to outside reading had become so frequent, it seemed worth while to make

a simple survey of the subject. The list which follows shows the number of pupils who have read at least one science article from each of the various magazines:

NUMBER OF PUPILS READING SCIENCE ARTICLES IN CERTAIN MAGAZINES

	(70) Gr. 7	(44) Gr. 8	(12) Gr. 9
Scientific American	2	3	0
Aero Digest	5	4	1
Popular Aviation	13	6	2
Coronet	8	5	0
Nature	25	11	0
Popular Science	37	37	9
Popular Mechanics	31	27	7
Reader's Digest	46	24	8
Life	70	32	11
National Geographic	61	28	9
Time	28	17	6
Newsweek	13	12	2
Fortune	19	5	0
Fur, Fish, and Game	11	3	1
Outdoor Life	22	8	2
Sports Afield	12	3	0
Saturday Evening Post	40	22	6
Collier's	22	21	0
Better Homes and Gardens	26	10	6
Field and Stream	14	6	2
Science Newsletter	3	1	1

Within the past five weeks, these 126 pupils have read voluntarily, science articles in 41 different magazines. Besides those listed above, one or more pupils have used such magazines as *Science Digest*, *Sportsman Pilot*, *Desert*, *Open Road for Boys*, *Boys Life*, *Model Airplane News*, and *Sky*.

When questioned as to their favorite science subject in magazines, they responded as shown in the table on the following page.

In order to get a frank and more subjective response on the subject of voluntary science-article reading, the children were asked to write answers to three questions, and to return their papers unsigned. They were asked first, "Why do you read science articles in the magazines?"

Some of the seventh grade answers were these:

"Because I like science."
"They are interesting to me and I do not get bored."
"To find out the interesting things in science which are new."
"Because they are interesting and I like them; then I can tell different

FAVORITE SCIENCE ARTICLE SUBJECTS

	(70) Gr. 7	(44) Gr. 8	(12) Gr. 9
Chemistry	12	0	0
Rocks and Minerals	0	2	1
The Earth	6	1	0
Weather	1	1	0
Present-Day Plants	2	0	0
Present-Day Animals	2	1	0
Prehistoric Plants	1	0	0
Prehistoric Animals	7	1	0
Photography	3	8	1
Electricity	3	4	2
Machines	4	0	0
Aviation	12	12	2
Medicine and Disease	17	14	6

facts to my father and discuss them with him and see what he says and thinks."

"Some of them look interesting and I read the first line and if it is interesting, I read the whole article."

Some of the eighth grade answers were these:

"It is fun to know new things in the scientific world."

"I read the different types of magazines for different reasons. I like best the picture magazines and short articles."

"Either because I have a hobby in the subject or because I want to know more about a new invention."

Some of the ninth grade answers were these:

"Curiosity."

"I am interested in being a doctor and read articles because of this."

"Because the beginning of the article was interesting."

"Because I am interested in science and I was curious."

The second question asked was this: "Did the Current Science Days that we have had from time to time influence your voluntary reading of science articles?" "Yes," said 48 seventh graders. "Very much so," said one. "Since I heard the science reports in class, I found them so interesting that I have kept my eyes open for science articles and stories." "Yes, because when I hear other people, I want to read them myself." "No," said 22 of the seventh graders. "I would have read the articles anyway." About two-thirds of the eighth grade and five-sixths of the ninth grade answered in the affirmative.

The third question asked was, Do you think you will continue to read science articles? To this, all but four seventh graders answered yes, and all but one eighth grader. The ninth grade

was one hundred per cent for future reading of articles. "Yes, if I find something original and interesting about science, I will enjoy reading it." "I expect to read them even more when I am older and understand them better." "Yes, it is important in this changing world."

As is evident in the listing of the magazines, some are to be found in most school and public libraries, but many are of the type subscribed for in the home or bought at newstands. In the latter case, frequency of magazine reading is dependent on the educational and economic status of the home. David, for instance, comes from a home where eight or nine magazines such as *Sky*, *Desert*, *Popular Science*, *Life*, *Time*, and *Fortune* are regularly present, while John sees only the *Saturday Evening Post* that he sells each week. Another factor influencing the type of science article read is the avocational and vocational interests of the children. There were a good many replies to the effect—"I read all the articles I can find about photography," or "medicine," or "airplanes."

Science teachers in junior and senior high schools plan and work and hope that the science courses they teach will help their pupils to live better lives not only during their school days but during their adult years. The habit of critical reading of science articles in magazines is one which should prove immensely valuable to each individual as he goes forward in this Age of Science.

BIGGER CROPS THROUGH HORMONE TREATMENTS

Bigger yields of a number of field crops were obtained by treating their seed before sowing, and in some instances by spraying the plants in the field, with plant hormones or growth-promoting substances, in large-scale tests reported by Prof. J. C. Ireland of Oklahoma A. and M. College. Of special potential practical interest is the fact that the stimulant he found most valuable, levulinic acid, can be made cheaply from waste materials. Its most important present use is in the making of plastics.

"The most outstanding results with levulinic acid were obtained in the treatment of cotton seed and cowpeas," Prof. Ireland stated. "The results show that there is not only more than a 50% increase in the yields over the untreated but that dusting with soyflour and 1% levulinic acid during the flowering period aids in the setting of bolls."

An acre of cotton thus treated would yield 838 pounds, worth about $134, as compared with a yield from an acre of untreated crop of only 581 pounds, worth $93. Cost of materials for treating one acre with levulinic acid is worth about $3, so that the method appears to be commercially profitable.

WOULD INTENSIFIED LABORATORY TEACHING AND TESTING AFFECT THE STATUS OF THE LECTURE-LABORATORY VERSUS THE LECTURE-DEMONSTRATION METHOD OF TEACHING CHEMISTRY CONTROVERSY?

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One is hesitant to add one more article to the lengthy list of splendidly written articles on the lecture-laboratory method versus the lecture-demonstration method of teaching chemistry controversy. This article will not attempt to summarize the advantages and disadvantages of the two methods since this subject has been quite comprehensively covered by previous writers.

The main point at issue in this controversy is the fact that various investigators have pointed out that, in factual knowledge as measured by objective tests, neither method shows any reliable difference or superiority over the other. Various writers have warned against the abandonment of laboratory work at this time since tests have not been developed which are capable of measuring the various intangible factors developed by the laboratory method. It has been pointed out that in addition students regard a chemistry course with laboratory work as being far more interesting than a chemistry course without laboratory work.

Since laboratory experimentation in the chemistry course was initiated partly to reenforce classroom instruction and because of the concept that we learn by doing, what teaching factors may have been neglected or partially neglected which would place the lecture-laboratory method of teaching chemistry at a slight disadvantage with respect to acquirement of factual knowledge when compared with the lecture-demonstration method?

Is it not possible that we have failed to develop to the utmost our teaching opportunities in the laboratory? Is it not possible that instructors have become involved too deeply in the routine of making up solutions, dispensing supplies or chemicals, mending apparatus . . . etc., that many teaching opportunities afforded by the laboratory are neglected? What teaching opportunities are afforded by the demonstration method that cannot

be duplicated by the laboratory method if the laboratory instruction is carefully planned and executed with laboratory sections of reasonable size? It is assumed, of course, that certain complicated or dangerous experiments will still be performed by the instructor regardless of the teaching method used.

Neglect by students to thoroughly inform themselves concerning the laboratory experiments to be performed, previous to their arrival in the laboratory, is another contingency which should not be neglected by the instructor. It is apparent that considerable valuable time, assigned to laboratory experimentation, is squandered by students indulging in this practice and therefore this time is forfeited insofar as acquirement of factual knowledge is concerned.

Is it not also possible that we have treated our laboratory work simply as an adjunct to the classroom work? Is it not possible that chemistry instructors have left to chance the absorption of knowledge in the laboratory by not adequately testing the knowledge assumed to be gained in the laboratory?

If the laboratory work is a worthwhile activity in chemistry, it would appear that this phase of chemistry instruction should be thoroughly tested for mastery shortly after the completion of an experiment. The laboratory phase of instruction should be comprehensively tested, also in the final or semester examination. Strict adherence to the three factors mentioned, during the teaching process, probabily will not result in startling gains in factual knowledge but will, in all probability, pay good dividends, when compared to the extra effort expended and more careful planning of laboratory instruction involved, through increased factual knowledge possessed by the students.

MODES OF HEREDITY IN HUMAN BEINGS

Genes, that determine hereditary characters in human beings as well as in lower organisms, are coming to be better understood in our own race despite the difficulties of studying them, Prof. Laurence H. Snyder of Ohio State University stated at the Dallas meeting of the American Association for the Advancement of Science. Certain genes, especially those that produce physical defects and constitutional diseases, have been traced to the particular chromosomes that are their abiding-places, and in some instances even their particular locus on a chromosome has been determined.

Most success has been achieved in the study of defects and other hereditary characters connected with the sex chromosomes. If a particular trait is inherited only by the sons in a given family line, the first place one would think of looking for it would be on the microscopic bit of protoplasm in the nucleus that determines that its possessor shall be a male. And very frequently such leads have led to positive results.

A CALENDAR OF THE BIRTHDAYS OF SCIENTISTS FOR FEBRUARY[1]

JAMES D. TELLER

College of Education, Ohio State University

Day	*Year*	*Name*	*Birthplace*	*Speciality*
1	1865	Henry Luke Bolley	Dearborn County, Indiana	Botanist
1	1800	Brian Houghton Hodgson	Lower Beach, Cheshire, England	Naturalist
3	1823	Spencer Fullerton Baird	Reading, Pennsylvania	Naturalist
3	1817	Achille Ernest Delesse	Metz, France	Geologist
3	1820	Elisha Kent Kane	Philadelphia, Pennsylvania	Scientist
3	1853	*Hudson Maxim	Orneville, Maryland	Inventor
4	1778	Augustin Pyrame de Candolle	Geneva, Switzerland	Botanist
4	1863	Antoine Francois Lacroix	Macon, France	Mineralogist
5	1840	*John Boyd Dunlap	Ayrshire, Scotland	Inventor
5	1795	Wilhelm Karl Haidinger	Vienna, Austria	Mineralogist
5	1811	William Henry Harvey	Summerville, near Limerick, Ireland	Botanist
5	1866	*Sir Arthur Keith	Old Machar, Aberdeen, Scotland	Anthropologist
5	1799	John Lindley	Cotton, near Norwich, England	Botanist
6	1796	John Stevens Henslow	Rochester, England	Botanist
7	1844	Alexis Pavlovich Fedchenks	Irkutsk, Siberia	Naturalist
7	1824	Sir William Huggins	London, England	Astronomer
7	1840	Sir Charles Warren	Bangor, Wales	Archaeologist
7	1834	*Dmitri Ivanovich Mendeléyev	Tobolsk, Siberia	Chemist
8	1879	Glover Merrill Allen	Walpole, New Hampshire	Naturalist
8	1727	Jean André Deluc	Geneva, Switzerland	Geologist
9	1791	Jean Cruveilheir	Limoges, France	Anatomist
9	1789	Franz Xaver Gabelsberger	Munich, Germany	Inventor
10	1875	Edward Wilber Berry	Newark, New Jersey	Palaeontologist
10	1842	Agnes Mary Clarke	London, England	Astronomer
10	1846	*Ira Remsen	New York, New York	Chemist
11	1847	*Thomas Alva Edison	Milan, Ohio	Inventor
11	1795	Charles Giles Danberry	Stratton, Gloucestershire, England	Scientist
11	1839	*Josiah Willard Gibbs	New Haven, Connecticut	Physicist
11	1823	Karl Wilhelm von Gümbel	Dannenfels, Germany	Geologist
12	1791	*Peter Cooper	New York, New York	Inventor
12	1785	Pierre Louis Dulong	Rouen, France	Chemist
12	1813	*James Dwight Dana	Utica, New York	Geologist
12	1809	*Charles Robert Darwin	Shrewsbury, England	Naturalist
12	1850	William Morris Davis	Philadelphia, Pennsylvania	Geologist
12	1815	Edward Forbes	Isle of Man, British Isles	Naturalist
12	1637	*Jan Swammerdam	Amsterdam, Holland	Naturalist
13	1672	Étienne Francois Geoffroy	Paris, France	Chemist
13	1851	George Brown Goode	New Albany, Indiana	Zoologist
13	1728	John Hunter	Long Colderwood, England	Physiologist
14	1844	Ludwig Boltzmann	Austria	Physicist
14	1776	Christian Gottfried Nees von Esenbeck	Erbach, Germany	Botanist
15	1812	Joseph George Cumming	Matlock, Derbyshire, England	Geologist
15	1809	André Hubert Dumont	Liege, Belgium	Geologist
15	1564	*Galileo Galilei	Pisa, Italy	Experimental Philosopher
15	1809	*Cyrus Hall McCormick	Rockbridge County, Virginia	Inventor
15	1861	Charles Edouard Guillaume	Fleurier, Switzerland	Physicist
15	1858	William Henry Pickering	Boston, Massachusetts	Astronomer
16	1848	*Hugo de Vries	Haarlem, Holland	Botanist
16	1822	*Sir Francis Galton	Birmingham, England	Anthropologist
16	1834	*Ernst Heinrich Haeckel	Potsdam, Germany	Biologist
16	1783	Jean Baptiste Omalius D'Hallay	Liege, Belgium	Geologist
16	1826	Hans Peter Jörgen Julius Thomsen	Copenhagen, Denmark	Chemist
16	1822	*James Thomson	Belfast, Ireland	Physicist
17	1856	Frederick Eugene Ives	Litchfield, Connecticut	Inventor
17	1723	Johann Tobias Mayer	Marbach, in Württemburg, Germany	Astronomer
18	1862	Boris Borisovich Golitsyn	St. Petersburg, Russia	Physicist
18	1790	Marshall Hall	Basford, near Nottingham, England	Physiologist
18	1838	*Ernest Mach	Turas in Moravia, Austria	Physicist
18	1745	*Alessandro Volta	Como, Italy	Physicist
19	1859	*Svante August Arrhenius	Uppsala, Sweden	Chemist
19	1473	*Nicolaus Copernicus	Thorn, Prussian Poland	Astronomer

19	1792	Sir Roderick Impey Murchison	Tarradale, Scotland	Geologist
20	1813	Edward Lyon Berthan	London, England	Inventor
20	1858	Howard Atwood Kelly	Camden, New Jersey	Gynaecologist
20	1837	Éleuthère Élie Nicolas Mascart	Near Valenciennes, France	Physicist
21	1822	Oliver Wolcott Gibbs	New York, New York	Chemist
21	1866	*August von Wassermann	Bamberg in Bavaria, Germany	Medical Research
22	1782	Johann Friedrich Ludwig Hausmann	Hanover, Germany	Mineralogist
22	1857	*Heinrich Rudolf Hertz	Hamburg, Germany	Physicist
22	1824	Pierre Jules Cesar Janssen	Paris, France	Astronomer
22	1796	Lambert Adolphe Quetelet	Ghent, Belgium	Astronomer
22	1857	William Trelease	Mt. Vernon, New York	Botanist
23	1817	Samuel Morison Brown	Haddington, Scotland	Chemist
23	1864	George Marinescu	Bucharest, Rumania	Neurologist
24	1849	John Henry Comstock	Janesville, Wisconsin	Entomologist
24	1866	Petr Nikolaievich Lebedev	Moscow, Russia	Physicist
25	1842	Nicolas Camille Flammarion	Haute Marne, France	Astronomer
25	1682	Giovanni Battista Morgagui	Forli, Italy	Anatomist
26	1786	Dominique Francois Jean Arago	Estagel, France	Physicist
26	1823	Joseph Le Conte	Liberty County, Georgia	Geologist
27	1869	Henry Chandler Cowles	Kensington, Connecticut	Botanist
28	1814	Edmond Frémy	Versailles, France	Chemist
28	1743	René Just Hoüy	St. Just, Oise, France	Mineralogist
28	1683	René Antoine Réaumur	La Rochelle, France	Scientist
28	1831	Edward James Stone	London, England	Astronomer
29	1808	Hugh Falconer	Forres, Scotland	Palaeontologist
29	1792	*Karl Ernest von Baer	Piep, Estonia	Biologist
29	1808	Charles Pritchard	Alberbury, Shropshire, Scotland	Astronomer
?	1802	*Sir Charles Wheatstone[2]	Gloucester, England	Physicist

[1] All data are taken from *The Encyclopaedia Britannica*, 14th edition. For the uses and limitations of such a calendar, the reader is referred to the article which accompanies the calendar for October in SCHOOL SCIENCE AND MATHEMATICS, Vol. XLI, pp. 611–619, Oct. 1941. The calendar for November will be found in *Ibid.*, p. 768, Nov. 1941, that for December in *Ibid.*, pp. 884–885, Dec. 1941, and that for January in *Ibid.*, pp. 87–88, Jan. 1942.

[2] The day of birth is not given in *The Encyclopaedia Britannica*, *The Encyclopedia Americana*, or *The Dictionary of National Biography*.

* The starred names have been used by the writer in various bulletin board projects during the past twelve years.

RESULTS OF AN INVENTORY TEST

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Teachers of secondary school mathematics will be interested in the results of an inventory test which was given at Alma College this fall. The test was given at the second meeting of the class to a group of 60 freshmen and sophomores enrolled in the introductory course in mathematical analysis. The problems given were taken in part from a group often used and referred to by Dr. Raleigh Schorling of the University of Michigan.

The results of the test reveal what teachers of mathematics teach well and what items are not covered as well as might be. It is interesting to note that there is no item on the test which every student could solve correctly, nor is there an item which everyone missed. The accompanying chart shows the number of students who missed each problem and the percentage of incorrect responses. The zero problem, number 14, was referred to by the instructor on the opening day of school but there were 14, or 23 percent, who failed to give the correct response.

These scores may not be typical but the writer believes they reveal some shortcomings; notably in teaching percentage, square root, and operations with decimal fractions. Although factoring is one of the major concepts developed in algebra, there were 38 of the 60 who could not factor $6x^2+7x+2$.

It is hoped that a study of the results of this test will be of value to all teachers of mathematics.

The Problem	Incorrect Responses	Percentage Incorrect
1. What is the square root of $(64)(81)a^2b^{16}$?	51	85
2. What are the factors of $6x^2+7x+2$?	38	63
3. Write as a decimal fraction: 399 millionths	36	60
4. What is the square root of 10609?	33	55
5. Simplify $3.12 \div \sqrt{.04}$.	33	55
6. How many factors has $2ab$?	31	52
7. What is the cube of 20.1?	28	47
8. What percent of 2 is $\frac{3}{4}$?	26	43
9. What percent of 25 is 75?	25	42
10. Simplify $(1.003)(1.3)^2$.	23	38
11. Simplify $1\frac{1}{2} \times 2\frac{1}{4} \times \frac{3}{4}$.	20	33
12. Simplify $4^1+3^2+2^3+1^4$.	18	30
13. What is the fourth power of 3?	15	25
14. Multiply 86.5 by 0.	14	23
15. Divide 8/15 by 3.2.	13	22
16. Multiply $2\frac{1}{2}$ by $3\frac{1}{4}$.	11	18
17. Divide 5/7 by 6/11.	11	18
18. Reduce 3/20 to a decimal fraction	10	17
19. Divide 7642.38 by 1000.	9	15
20. What is the average of 4, 11, 0, and 9?	7	12
21. $\frac{1}{4}+\frac{1}{5}$ equals how many hundredths?	6	10
22. If d is the cost per dozen, what is the cost of one?	6	10
23. Divide $3\frac{1}{2}$ by $1\frac{3}{4}$.	5	8
24. If 23.186 is multiplied by 7.79, how many digits come after the decimal point?	4	7
25. What is the sum of $7\frac{5}{6}$ and $4\frac{1}{2}$?	3	5

It is a relatively simple thing to mobilize a regimented people. The order is issued, the heels click together, the minds click together, and that is that. But to organize the human resources of a free people is a complex social process. Authoritarianism mobilizes from without. The mobilization of a democracy is from within. The first is artificial, and the spirit of the people may break the shackles that hold them in line. The second is natural and made of durable stuff which contains within itself its own cohesive properties. Dictators may mobilize men as they do machines, but only a democracy can mobilize the heart and soul and will of the people.—*Educational Policies Commission.*

THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

Various investigations by committees and individuals on phases of the teaching of the basic sciences in schools and colleges throughout the country have led to a recognition that many of the problems cannot be solved except by cooperative effort of all concerned. Consequently, several informal meetings of interested people have been initiated by Professor K. Lark-Horovitz, of Purdue University. These meetings have been attended by mathematicians, physicists, chemists, biologists, and educationists. In April, 1941, the Cooperative Committee on Science Teaching was created by representatives of several scientific societies. Robert J. Havighurst, of the University of Chicago, was elected Chairman. Glen W. Warner, Wilson Junior College, Chicago, was named Secretary.

The Need for a Cooperative Committee

There is need for cooperation among groups of scientists, teachers of all the basic sciences, educational experts, and school administrators on problems which no one group can solve working alone. Many of these problems deal with science in the secondary school, such as, licensing or certification of science teachers for high schools, the training of science teachers, and correlation of the sciences in the high-school curriculum.

Membership

The Committee consists of the following:
Representing the American Association of Physics Teachers
K. Lark-Horovitz, Purdue University.
Glen W. Warner, Wilson Junior College, Chicago.
Representing the American Chemical Society
B. S. Hopkins, University of Illinois.
Martin V. McGill, Lorain High School, Lorain, Ohio.
Representing the Mathematical Association of America
A. A. Bennett, Brown University.
Raleigh Schorling, University of Michigan.
Representing the Union of Biological Societies
Oscar Riddle, Department of Genetics, Carnegie Institution
Walter F. Loehwing, Iowa State University
Representing the National Association for Research in Science Teaching
G. P. Cahoon, The Ohio State University.
Robert J. Havighurst, The University of Chicago.

Relation of the Committee to Parent Organizations

The Committee will have an advisory relation to its parent organizations. It will report to them regularly through their representatives. Its recommendations will be released for publication in the various scientific and educational journals with the aim of securing comment and criticism by members of the sponsor organizations.

Agenda of the Committee

Licensing or Certification of Secondary-School Science Teachers

This problem, with its associated problem of combinations of subjects to be taught by the beginning teacher in the small high school, is generally recognized as a serious one. Most teachers begin their work in small high schools of two hundred or fewer students. In such high schools a teacher must teach three or four different subjects. Therefore, a college graduate

with highly specialized training in a single science is at a disadvantage in securing a position or in his teaching if he is appointed. The Committee hopes to formulate a policy to which all the scientific societies can agree and which suits the realities of the teaching situations. The Committee hopes to make this study so thorough and its recommendations so practical that its report can be used by certification authorities as a basis for action.

The College Training of Prospective Science Teachers

The Committee recognizes the difficulty of preparing science teachers for such broad teaching assignments as are given to most new teachers. This problem will require careful study with the aim of planning a program which will secure the necessary breadth of science training, give adequate opportunity for specializing in one science, and provide for professional courses in education as well as a sufficient number of courses for general culture.

Exploratory Studies of the Secondary-School Science Curriculum through Workshops and Conferences

The Committee hopes to stimulate the science departments of a number of colleges and universities to bring secondary-school teachers to their campuses for cooperative work on their educational problems. Out of workshops and conferences held at colleges and universities would probably come plans for improved science courses. These activities would provide good in-service training for science teachers and would enable the secondary-school teachers to make their problems and their points of view evident to the college scientists.

Problems of State or Local Agencies Needing the Services of Educational Consultants on Questions Pertaining to Science Teaching

The Committee offers its services as a consultant to state or local agencies working on problems pertaining to science teaching. The Committee may thus provide direct connection between such agencies and the societies represented on the Committee. For example, the Committee might become associated in a curriculum study in some state, cooperating with the state department of education and the college and secondary-school science teachers of that state. The results of such a project might prove valuable to other states.

Meetings

Meetings have been held in Chicago, April 19, 1941, and November 22, 1941.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1732, 4. *Kenneth P. Kidd, Nashville, Tenn.*
1732. *William Piercy, Willard, N. Y.; Warren Coombs, East Romulus, N. Y.; Edna Kent, Auburn, N. Y.*
1713. *John P. Hoyt, Cornwall-on-Hudson, N. Y.*
1734. *Helen M. Scott, Baltimore, Md.*

1735. *Proposed by Celia Miller, Interlaken, N. Y.*

If the ex-circle of triangle ABC, which is tangent to BC, equals the circumcircle, show that $\cos A = \cos B + \cos C$.

Solution by Aaron Buchman, Buffalo, New York

Let r be the radius of the circumcircle and of the ex-circle tangent to BC.
Using the circumcircle, $BC = 2r \sin A$
Using the ex-circle, $BC = r \tan \frac{1}{2}B + r \tan \frac{1}{2}C$
Equating and dividing by r,

$$2 \sin A = \tan \tfrac{1}{2}B + \tan \tfrac{1}{2}C. \tag{1}$$

Using two of the various formulas for tangent of the half angle in terms of functions of the whole angle,

$$2 \sin A = \frac{\sin B}{1+\cos B} + \frac{\sin C}{1+\cos C} \tag{2}$$

$$2 \sin A = \frac{1-\cos B}{\sin B} + \frac{1-\cos C}{\sin C}. \tag{3}$$

Clearing (2) and (3) of fractions, subtracting the resulting equations, replacing $\sin B \cos C + \cos B \sin C$ by $\sin A$, and dividing by $2 \sin A$,

$$\cos B + \cos C + \cos B \cos C - \sin B \sin C = 0. \tag{4}$$

But $\cos B \cos C - \sin B \sin C = \cos(B+C) = -\cos A$.
Using this relation in (4), $\cos B + \cos C = \cos A$.

Solutions were also offered by M. Kirk, West Chester, Pa.; Paul D. Thomas, Durant, Okla.; Harry Denniston, Dundee, N. Y.; Walter R. Warne, Rochester, N. Y.; Susie Thomas, Carbondale, Pa. Clara Broadhear, Fayette N. Y. and the proposer.

1736. *Proposed by Ethel Kunes, Starkey, N. Y.*

In an oblique triangle ABC; if $C = 60°$, show that

$$\frac{1}{a+c}+\frac{1}{b+c}=\frac{3}{a+b+c}.$$

Solution by Isaac Adair, West Fayette, New York

From the law of cosines, since $\cos 60=\frac{1}{2}$,

$$c^2=a^2+b^2-ab, \text{ whence} \tag{1}$$

$$a^2+b^2-c^2-ab=0 \text{ which can be written} \tag{2}$$

$$(a^2+ab+2ac)+(ab+b^2+2bc)+(ac+bc+2c^2)=(3a^2+3bc)+(3ac+3c^2). \tag{3}$$

By factoring

$$(a+b+2c)(a+b+c)=3(a+c)(b+c) \tag{4}$$

$$\frac{(a+c)+(b+c)}{(a+c)\quad(b+c)}=\frac{3}{a+b+c} \tag{5}$$

$$\frac{1}{a+c}+\frac{1}{b+c}=\frac{3}{a+b+c}.$$

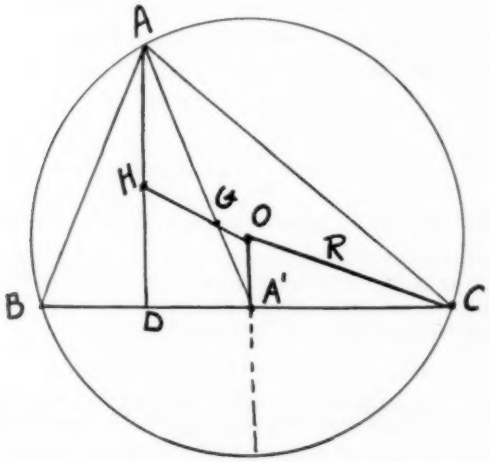
Solutions were also offered by M. Gordon Duvall, Cincinnati, O.; George Jennings, East Varick, N. Y.; Kenneth P. Kidd, Nashville, Tenn.; Aaron Buchman, Buffalo, N. Y.; Morris Jerome, Los Angeles, Calif.; S. E. Field, Ironwood, Mich.; Roy Wild, New Boston, Mo.; Paul D. Thomas, Durant, Okla.; Lester Bolander, Philadelphia, Pa.; Mary Ball, Elm Beach, N. Y.; Malcolm Kirk, West Chester, Pa. and the proposer.

1737. *Proposed by Ethel Kunes, Starkey, N. Y.*

In any triangle if H is the orthocenter, show that $AH=2R\cos A$, where R is the circumradius.

Solution by Paul D. Thomas, Durant, Oklahoma

If O is the circumcenter, G the centroid; H, O, G are collinear (Euler). Let A' be the midpoint of BC. The triangles AHG and GOA' are similar.



Since

$$AG=2GA', \qquad AH=2OA'. \tag{1}$$

Angle A = Angle BOA' = angle COA' (consider the arc of the circumcircle subtended by BC).

$$OA'=R\cos COA'=R\cos A. \tag{2}$$

Substitute from (2) in (1) to get

$$AH=2R\cos A.$$

Solutions were also offered by M. Gordon Duvall, Cincinnati, O.; Marcellus Dreiling, Collegeville, Ind.; Aaron Buchman, Buffalo, N. Y.; William Piercy, Willard, N. Y.; Evangeline Fazio, Carlisle, Pa.; Walter Kunes, Glenora, N. Y.; Miss Ethel Kunes, Starkey, N. Y.

1738. *No solution was offered.*

1739. *Proposed by J. C. Bedine, Phoenix, Ariz.*

If the roots of $ax^2+2bx+c=0$ be real and different, those of $(a+c)(ax^2+2bx+c)=2(ac-b^2)(x^2+1)$ will be imaginary and vice versa.

Solution by M. Gordon Duvall, Cincinnati, Ohio

For the roots of the first equation to be real and different $4b^2-4ac$ must be greater than zero, or $b^2>ac$.

Expanding the second equation and collecting terms we get

$$x^2(a^2-ac+2b^2)+x(2ab+2bc)+c^2+2b^2-ac=0. \tag{1}$$

The condition for imaginary roots is that its discriminant be less than zero. This is that

$$a^2b^2+2abc^2+b^2c^2<(a^2-ac+2b^2)(c^2+2b^2-ac) \tag{2}$$

$$0<a^2b^2-6abc^2+b^2c^2+2a^2c^2-a^3c-ac^3+4b^4 \tag{3}$$

By facturing (3) becomes

$$0<[c^2+a^2+2b^2+2(b^2-ac)](b^2-ac). \tag{4}$$

Now if $b^2-ac>0$ then (4) is true.

Solutions were also offered by Malcolm Kirk, West Chester, Pa.; Marcellus Dreiling, Rensselaer, Ind.

1740. *Proposed by David X. Gordon, Brooklyn, N. Y.*

Eliminate m from the equations

$$y=mx+\sqrt{a^2+b^2m^2}$$

$$y=\frac{x}{m}+\sqrt{a^2+\frac{b^2}{m^2}}.$$

First Solution by Aaron Buchman, Buffalo, New York

Since the second equation is the first with m replaced by $1/m$, then the condition that m satisfy both equations is equivalent to the condition that these equations be *reciprocal* equations in m.

Eliminating radicals from the first equation,

$$(x^2-b^2)m^2-2xym+y^2-a^2=0. \tag{1}$$

Since (1) is a reciprocal quadratic whose middle term is not zero, the coefficient of the second degree term is equal to the constant term.

Therefore $x^2-b^2=y^2-a^2$ or $x^2-y^2=b^2-a^2$, which is a relation free of m.

Second Solution by Walter R. Warne, Rochester, New York

The two equations easily reduce to:

$$(x^2-b^2)m^2-2mxy+y^2-a^2=0 \quad (1)$$

$$(y^2-a^2)m^2-2mxy+x^2-b^2=0. \quad (2)$$

Upon subtracting and dividing

$$m^2=1 \text{ when } x^2-y^2+a^2-b^2\neq 0.$$

By substitution of $m=1$ and $m=-1$
Two equations result as eliminants, namely

$$y+x=\sqrt{a^2+b^2}$$

$$y-x=\sqrt{a^2-b^2}.$$

Solutions were also offered by Malcolm Kirk, West Chester, Pa.; M. Gordon, Brooklyn, N. Y.; A. D. Suttle, Jr., State College, Miss.; Kenneth P. Kidd, Nashville, Tenn.; S. E. Field, Ironwood, Mich.; Roy Wild, New Boston, Mo.

STUDENT HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted to this department. Teachers are urged to report to the Editor such solutions.

No solutions were offered for this issue.

PROBLEMS FOR SOLUTION

1753. *Proposed by John D. Biggerstaff, Portland, Ore.*

Prove that

$$\frac{1}{1\cdot 3\cdot 5\cdot 7\cdot 9\cdot 11}+\frac{1}{13\cdot 15\cdot 17\cdot 19\cdot 21\cdot 23\cdot}+\cdots=\frac{23\pi}{23040(17+9\sqrt{3})}.$$

1754. *Proposed by Addie Clock, Burdette, N. Y.*

Show that $x^4+px^3+qx^2+rx+s=0$ may be solved as a quadratic if $r^2=p^2s$. (From Hall and Knights' Higher Algebra.)

1755. *Proposed by Hugo Brandt, Chicago, Ill.*

Determine the area common to the two curves whose equations are $x^2+y=a$ and $y^2+x=a$.

1756. *Proposed by T. A. Pickett, So. Weymouth, Mass.*

The difference of the squares of any two odd integers is divisible by 8.

1757. *Proposed by Lucille Rich, Albany, N. Y.*

Exhibit the roots of $x^4+px^2+1=0$ in the form $a, b, \frac{1}{a}, \frac{1}{b}$.

1758. *Proposed by I. N. Warner, Platteville, Wis.*

A good student of mathematics was inducted in the army with the number 36216181. In making a study of this number he discovered that the sum of the digits is 28, a "perfect" number. What he wants to know is this: Is 36216181 a prime number? Can it be determined without using a table of primes?

SCIENCE QUESTIONS

February, 1942

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio

Readers of SCHOOL SCIENCE AND MATHEMATICS *are asked to contribute: Questions, Answers, Comments, Suggestions—Whatever is new or interesting in the teaching of Science.*

Your classes and yourself are invited to join the GQRA (Guild Question Raisers and Answerers). Four hundred and eighteen (418) others have already been admitted to membership by answering a question or proposing one that is published.

Our motto for 1942 is—

KEEP UP WITH SCIENCE AND INDUSTRY

WATCH THE NEWSPAPERS FOR ITEMS

SOME EXAMPLES

944. *From the "Niagara Falls Gazette," December 31, 1941.*

"The Remarkable Story of Salt" by Dr. H. J. Barrett, Sales Research Manager, R. & H. Chemicals Dept., E. I. du Pont de Nemours.

SALT—(1) A medium of exchange;
(2) A pledge uniting people in blood brotherhood;
(3) word "salary" comes from Latin "salarium"—that part of a Roman soldier's pay which was paid in salt;
(4) an increasingly important industrial raw material;
(5) used in making a wide variety of useful products.

Useful Products

(a) To make the bright, shiny surface of your razor (NaCN—for case-hardening; and other metal cyanides for protective coatings;
(b) To produce wear-resistant metal parts of your automobile (NaCN);
(c) To make the powder that keeps your gums healthy ($NaBO_3 \cdot 4H_2O$—sodium perborate);
(d) To make solvents to remove spots from women's gowns and men's suits (C_2Cl_4—Perchlorethylene);
(e) To make bleaches for wool and other fibers (Na_2O_2—sodium peroxide or H_2O_2—Hydrogen peroxide);
(f) To make fumigants for protecting foods from pests (NaCN to make HCN);
(g) To make refrigerants for your electric ice-box (CH_3Cl—Methyl-chloride, $C_2H_2Cl_2$—Methylene chloride);
(h) To make products to purify the water you drink (Liquid Cl); and so on for many more chemical materials derived from salt.

"To the chemist salt is sodium chloride—a compound of sodium and chlorine.

"At the Niagara Falls plant, the first task is to reduce the material to its elemental forms. Purified salt is carried to the Downs cells where a powerful electric current melts it and the electrochemical process continues until the molten mass is broken down into two components.

"*Sodium*—The beautiful silvery white metal—is drawn off in the molten state and piped to other operations, storage tanks and tank cars, or it is made into bricks of various sizes.

"The *chlorine*, a greenish-yellow gas, is collected for use in making other chemicals to be mentioned later."

IMPORTANCE OF SODIUM

Name the *least expensive pure metal.*

Not "ingot" iron—one cubic foot of the double-refined metal iron weighs 480 pounds and, at current prices, is worth $27.46.

Sodium (one cubic foot) weighs only 61 pounds and currently commands a price of $9.46.

Sodium alloys with lead and with zinc forming products whose reactions are easier to control than sodium alone; introduced into molten metals such as brass and bronze to remove oxygen and other impurities.

Sodium has high electrical conductivity; has present or prospective use "as a heat-transfer medium in equipment where intense heat is to be applied or removed and where close temperature control is desired."

"Metallic sodium has long been used in the manufacture of synthetic dyes, particularly indigo."

Sodium is used in manufacture of tetra-ethyl lead which contributes "anti-knock" properties to motor fuels.

Frequently, text-book material is years behind daily use and commercial practice. Articles in the daily press, in magazines and in manufacturers' publications (such as "Steel Facts") are almost surely up-to-date, are interestingly written, and will serve as valuable source material for "lesson-units." Their use is commended to teachers. Talk with your local manufacturers; read the newspapers; make a scrap-book of the material you collect.

Your classes will become more interesting!!!

Note—American Iron & Steel Institute publishes "Steel Facts." Undoubtedly, a letter of request to 350 Fifth Avenue, New York, N. Y. would put you on their mailing list.

FLIES CARRY POLIOMYELITIS (INFANTILE PARALYSIS)

945. *Reported in "Science," December 18, 1941.*

Doctors Albert B. Sabin and Robert Ward of the University of Cincinnati report that infected flies were found in a modern, clean and thoroughly screened government housing project in Cleveland. In October, 1941, Yale physicians reported infected flies in four widely separated areas—Cleveland, Atlanta, Ga., Connecticut and Alabama.

AUTO TIRES FROM GUAYULE RUBBER

946. *From "Cleveland Plain Dealer," December 19, 1941. Article by* John. W. W. Sullivan, Sc.D.

"The Mexican thistle-like guayule plant is a potential source for automobile tires and many other products. An improved strain can be raised in California, Arizona, and Texas. Planted on a sufficiently large scale now, within two to four years, it could supply the total demand for rubber in the United States."

Capital investment required only one-fourth that required by synthetic rubber.

Rubber consumption in the United States, 1941, was 683,000 tons. " . . . Shrubs planted on 100,000 acres the first year would be transplanted on 1,000,000 acres the second year and harvested." Estimated cost of rubber thus obtained about 10 cents per pound.

7,000 long tons of guayule rubber are annually grown and processed in Salinas valley, California.

MUM, THE LITTLE SKUNK, HELPS EDUCATION

947. *Margaret Suhr Reed, reporter, writes up class demonstration for School of Education (Western Reserve University) by Fourth Grade Class of Miss Blanche Scott of Caledonia School, Cleveland Heights, in "Cleveland Plain Dealer," December 8, 1941.*

Mum, and the class, demonstrate all about skunks except the odor, for Mum is a deodorized wood pussy. Interesting Reading!!!

SOCIAL SCIENTISTS! ATTENTION!

948. *Some Headings from Articles in "Steel Facts" for December, 1941.*

(a) "Colonial Ironworks Did Heroic Job in Equipping Continental Troops" (1775–1781). Historical.

(b) "USA and Allies Can Make Twice as Much Steel as Axis Countries." (1941). Economic.

(c) "Safety Record of Steel Mills in 1940 Was Best in History," Accident hazard down 50%. Social Security.

(d) "Many Steels Developed for Peace Time Uses of Now Serving Defense." Manufacturing.

(e) "Steel Mills Consume 20% of All Power Used in U. S. Industries" 9,550,000 H. P. required to keep industry's wheels turning. Statistics.

(f) "Steel Industry Is Conserving Metals." Reducing use of five strategic metals. Conservation.

STEEL QUIZ FOR DECEMBER, 1941, AND ANSWERS

949. *"Steel Facts" for December, proposes to its readers, and answers the following.*

? ? STEEL QUIZ ? ?

The correct answers to this quiz appear below. An average score is six right out of ten.

1. As compared with production of electric furnace steel in 1915, American production this year will be: (a) *55 times higher;* (b) *10 times higher;* (c) *5½ times higher.*

2. Home scrap is steel scrap obtained from: (a) *house to house collections;* (b) *steel plants;* (c) *local industries which consume steel.*

3. An alloy steel airplane propeller blade, which weighs 52 pounds in finished form, begins as a rough forging weighing: (a) *75 pounds;* (b) *150 pounds;* (c) *240 pounds.*

4. The steel transmission of a 28-ton medium tank weighs as much as (a) *three light automobiles;* (b) *two motorcycles;* (c) *one refrigerator.*

5. Among the materials used in steel mill operations are: (a) *sugar and salt;* (b) *vinegar and mustard;* (c) *pepper and cinnamon.*

6. Wire, pipe and other steel materials used for the folding cots of an army of 1,400,000 men total: (a) *450,000 feet;* (b) *4,500,000* feet; (c) *451,000,000 feet.*

7. The deoxidation of steel by the addition of aluminum is generally accomplished in: (a) *the furnace;* (b) *the ladle or ingot mold;* (c) *the soaking pit.*

8. Homogenous armor plate differs from face-hardened armor plate in that it is: (a) *equally hard throughout its thickness;* (b) *harder inside than on the surface;* (c) *welded rather than riveted.*

9. Steel production in the first 11 months of 1941 set a new peak which exceeded the best previous record for the same period by: (a) *5 per cent;* (b) *15 per cent;* (c) *25 per cent.*

10. The first iron used in North America was made from: (a) *European ore;* (b) *American meteorites;* (c) *American ore.*

ANSWERS TO QUIZ

1. (a) Production of high quality electric furnace steels, largely for defense, will total close to 3,000,000 tons in 1941, or over 55 times the 1915 output.

2. (b) Home scrap is produced by the steel mills themselves, as a by-product of finishing operations.

3. (c) The rough forging from which an alloy steel airplane propeller is made weighs 240 pounds, nearly five times as much as the finished product.

4. (a) The alloy steel transmission of a 28-ton medium tank weighs 7600 pounds, or as much as three light automobiles.

5. (a) Sugar is sometimes used as a lining for ingot molds, while salt is used to explode scale off hot rolled plate.

6. (c) The beds for 1,400,000 soldiers require 451,000,000 feet of wire, pipe and other steel products.

7. (b) Aluminum and other deoxidizers are generally added to molten steel in the ladle or in the ingot molds into which it is poured from the ladle.

8. (a) Homogenous armor plate differs from face-hardened plate in that it has uniform hardness throughout its thickness.

9. (c) About 75,600,000 tons of steel were produced by the American steel industry in the first 11 months of 1941, which exceeded by 25 per cent the previous record output in the corresponding period of 1940.

10. (b) The natives who preceded European settlers in this country occasionally used iron implements made from meteorites.

WANTED !!!

NEW MEMBERS OF THE GQRA

Come in with 418 others

SYNTHETIC RUBBER WASHERS

Rubber must be saved to the utmost in these days. Washers, for hot water faucets, of synthetic rubber have been found by tests to be superior to washers of natural rubber. The testing machine condensed five normal years of use into 50 hours by opening and closing the faucet 30 times a minute. The water was maintained at 180 degrees Fahrenheit. Washers of natural rubber cracked under this treatment causing the faucet to leak. The synthetic rubber washers showed only moderate wear and were still tight.

BOOK REVIEWS

THE HARVARD BOOKS ON ASTRONOMY, edited by Harlow Shapley and Bart J. Bok. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa.

The Blakiston Company is presenting a series of nine books by members of the Harvard Observatory staff written to give the general public the latest discoveries in the field of astronomy. Four of the series have now been published. They were written by authorities in the various areas of the subject and edited by Professor Harlow Shapley and Dr. Bart J. Bok, hence they are not only reliable but follow a unified plan. All are artistically illustrated, printed on high grade paper, and substantially bound. Amateur astronomers, beginning students in astronomy, and all laymen interested in the subject will want this set. In places, however, the discussions become somewhat technical and will require considerable careful thinking.

EARTH, MOON AND PLANETS, by Fred L. Whipple, *Harvard College Observatory*. Cloth. Pages vi+293. 14.5×21.5 cm. 1941. Price $2.50.

Now while the four brightest planets are visible is a most opportune time to read this book. However, a Planet Finder and Star Chart is inclosed in a pocket in the back of the book. By its use and a table in the appendix any of the planets visible to the unaided eye may be located during the period from 1940 to 1970. This book gives all the chief characteristics of each planet; its position, size, motions, atmosphere, possibilities for life, satellites. The origin and evolution of the solar system is given special consideration. This book is a good one for the beginner to read first because it is less technical than the others.

BETWEEN THE PLANETS, by Fletcher G. Watson, *Harvard College Observatory*. Cloth. Pages v+222. 14.5×21.5 cm. 1941. Price $2.50.

In this book we get the story of the asteroids, comets, meteors and meteorites. From the discovery of Ceres in 1801 by Piazzi the author runs rapidly over this interesting hunt for small planets to the present with about 3,000 known asteroids. Their locations, orbits, variations in brightness, and other features are briefly discussed. In two short chapters the motions and structure of comets are described and some interesting speculations on their origin given. More than half of the book is given to meteors and meteorites. This section is most satisfying and must indicate the author's major interest. The book closes with an interesting discussion of the Zodiacal light and the counter-glow or Gegenschein.

THE MILKY WAY, by Bart J. Bok and Priscilla F. Bok, *Harvard College Observatory*. Cloth. Pages v+204. 14.5×21.5 cm. 1941. Price $2.50.

In this book the layman gets the astronomer's answer to the questions so often asked: Where are we in the universe? Does the sun move? Which way is it going? What is the past history of our galaxy? What of its future? and many others. The evidence supporting the answers is presented by explanations, diagrams, and tables of data. The authors show how these data were gathered and explain the necessity for international cooperation over long periods of time. Evidence obtained by use of the astronomer's most modern tools such as the McCuskey and Scott automatic star counter and the Schmidt camera bring the account right up to the present. What would the Milky Way look like from a distance? Chapter ten gives the probable appearance.

THE STORY OF VARIABLE STARS, by Leon Campbell and Luigi Jacchia, *Harvard College Observatory*. Cloth. Pages v+226. 14.5×21.5 cm. 1941. Price $2.50.

How variable stars are found and the methods of observing them make up the first two chapters of this book. The third chapter on "Using the Observations" is technical but may be omitted by the lay reader. The succeeding chapters discuss the types of variables—pulsating stars, both long period and short period, red variables, novae, erratic stars, and eclipsing stars. In each class the general characteristics are given with descriptions of several specific cases, and the theory with supporting evidence.

After reading these four books the reviewer is anxiously waiting the appearance of the remaining five of the series.

G. W. W.

UNIVERSITY PHYSICS, by F. C. Champion, M.A., Ph.D. (Cantab.) *Lecturer in Physics, University of London*. Blackie & Son, Limited, London and Glasgow.

PART I. GENERAL PHYSICS. Cloth. 157 pages. 14.5×22 cm. 1939. Price. $1.50.

PART II. HEAT. Cloth. 148 pages. 14.5×22 cm. 1940. Price $1.50.

PART III. LIGHT. Cloth. 172 pages. 14.5×22 cm. 1941. Price $1.50.

This is a series of five textbooks covering the field of physics and designed for a two-year university course. Book IV on Sound and Book V on Magnetism and Electricity are in preparation. They are well designed for classroom use: bold face type is used for technical expressions and definitions, italics for emphasis on other important facts; completely lettered drawings are abundant; the mathematical analysis is complete; a short list of problems follows each chapter; a more extensive list with answers and hints for solution is given at the end of each book. A working knowledge of the calculus is presupposed. In Book I legends for the figures are not given but this defect is corrected in Books II and III.

G. W. W.

MATHEMATICS, by John W. Breneman, *Associate Professor of Engineering Mechanics*. Prepared under the Direction of the Division of Engineering Extension, The Pennsylvania State College. Cloth. Pages xii+210. 15×23 cm. 1941. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.75.

This is a book for those who are preparing for technical work and find themselves deficient in mathematical preparation. No better description can be given than that of the author in his "Preface" from which we quote:

"The subject includes a brief review of arithmeric, fractions, algebra including simultaneous and quadratic equations and the use of handbook tables which have been incorporated into the appendix. The fundamentals of plane geometry are covered by the use of geometrical constructions, whereby geometrical theorems are made into practical problems. The use of trigonometry has been dealt with in a useful manner and incorporates the fundamental laws solved by both natural and trigonometric functions."

This book should prove very useful in the present emergency.

G. W. W.

MECHANICS, by John W. Breneman, *Associate Professor of Engineering Mechanics*. Prepared under the Direction of the Division of Engineering Extension, The Pennsylvania State College. Cloth. Pages x+141. 15×23

cm. 1941. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.50.

This is a beginner's book on mechanics which not only covers the usual topics treated in a textbook of elementary mechanics but gives a chapter on screws, gears, gear trains, and other practical mechanisms. The book is characterized by simple discussions, well-made drawings, and an abundance of carefully graded problems. There are 178 diagrams and 150 problems. The appendix includes 16 pages of useful tables. Students using this text should have a working knowledge of algebra, geometry, and trigonometry.

G. W. W.

STRENGTH OF MATERIALS, by John W. Breneman, *Associate Professor of Engineering Mechanics*. Prepared under the Direction of the Division of Engineering Extension, The Pennsylvania State College. Cloth. Pages x+145. 15×23 cm. 1941. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.50.

This is an elementary text for beginning classes, for correspondence students, and for those who study at home without other help. High school mathematics through trigonometry is required. The theoretical material is reduced to a minimum. To make the text as simple and practical as possible many illustrative problems are completely solved. The chapter headings indicate the content: Simple stresses, Shear, Riveted joints, Stresses in thin walled cylinders—welds, Torsion, Beams—shear and moment diagrams, Stresses in beams, Beam deflections, Combined axial and bending stresses —eccentric loads, Columns, Materials. There are 137 drawings and 121 problems for solution.

G. W. W.

MATHEMATICS—ITS MAGIC AND MASTERY, by Aaron Bakst. Cloth. Pages xiv+790. 14×21.5 cm. 1941. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y.

To quote from the preface, "This book is designed to make mathematics interesting. . . . Although designed for amusement, . . . not restricted merely to novel . . . and entertaining mathematical stunts . . . but also . . . an easily read and clearly understandable discussion of mathematical processes." In general the objectives have been admirably met. At times it seems that there is an unnecessary amount of material, but it can be skimmed when looking for some particular concept, and certainly it is better to err in this direction than in the other. The range is large, from counting to material in the calculus, with much consideration of applications.

This book is almost a *must* for the high school library, it is a fertile source of supplementary material for classroom work as well as mathematical clubs. It would be hard to find any topic now taught in high school in which there would not be interesting sidelights, the same is true for much junior college work. It is hard to select any particular portion of the book for comment, but some items may show the scope: there are five pages of suggestions which might help one grasp the magnitude of large numbers; twenty-two pages on codes; ten pages on rapid calculation; much material on mathematical tricks, including a section on how to make your own; over twenty pages of excellent material on installment buying; a discussion of the number e, including such applications as parachute jumping, long distance 'phoning, submarine warfare, suspension bridges. A chapter which in

an ordinary text book would probably be entitled "Elementary Ballistics" is called "The Firing Squad and Mathematics" and concludes with the section entitled, "If You Want to Hit Your Target, Don't Aim at It!" The mathematics of latitude is employed to show a difference of about three and one half inches between the same javelin throw in Los Angeles and in Berlin.

There is an appendix covering more formal material, including tables of logarithms and trigonometric functions. Answers are provided to the sets of problems which appear at irregular intervals.

The reviewer predicts that several portions of this book will very rapidly become worn out if it is placed within the reach of the student body.

CECIL B. READ
University of Wichita

GALOIS LECTURES, Addresses Delivered by Jesse Douglas, Philip Franklin, Cassius Jackson Keyser, and Leopold Infeld at the Galois Institute of Mathematics, Long Island University, Brooklyn, New York. Cloth. 124 pages. 12.5×19 cm. Scripta Mathematica, Yeshiva College, New York, N. Y. Price $1.25.

Four lectures comprise the subject matter: Survey of the Theory of Integration; The Four Color Problem; Charles Sanders Peirce as a Pioneer; The Fourth Dimension and Relativity. The first is an introduction to the theory of integration for non-specialists. There is a description of the Riemann, Stieltjes, and Lebesgue integral, with comparison of the most essential properties, and brief reference to the Denjoy integral. The material should not be termed elementary, but does provide a very satisfactory survey. The second lecture gives a very fine summary of the four color problem, starting with a brief history. The five color theorem is proved, and several illustrations show how the four color problem may be simplified; certain alternative theorems are presented, as well as some specialized theorems on coloration. This should prove a very interesting reference, in particular it provides material for mathematics club activities.

The last two lectures are shorter. There is a valuable summary of the work of Peirce, particularly in the field of logic, which he by no means considered to be the same as mathematics. The fourth lecture was a radio broadcast, and is given in the form of a dialogue with a clever pupil. Some of the concepts are presented in a very nice manner.

Because of the compact nature of the book; the interest in the topics; the authority of the lecturers; and the very readable style, one cannot help but recommend this small volume as a very fine addition to private or institutional library.

CECIL B. READ

THE INTERVIEW METHOD OF TEACHING QUALITATIVE ANALYSIS, by Alfred M. Ewing, *Professor of Chemistry, Texas Wesleyan College, Fort Worth, Texas.* Revised and Enlarged. Paper. 52 pages. 20×27.5 cm. 1940. Published by the Author. Price $1.00.

This book is an elementary one, built and designed to give the beginning student a general idea of how qualitative analysis is done. This book may be used the latter part of the first year of college chemistry.

There is nothing new in this book except the arrangement. The diagrammatic scheme of analysis of each group is always opposite the reading page pertaining to that group. The book is composed of a Practical Part and a Theoretical Part. The practical part includes the analysis for twenty-five of the most common elements and twenty of the most common acid

radicals. In the theoretical part the most important theoretical topics pertaining to qualitative analysis are discussed.

E. G. M.

NEW WORLD OF CHEMISTRY, by Bernard Jaffe, *Chairman, Department of Physical Science, Bushwick High School, New York City*, and *author of "Outposts of Science, Crucibles, and Chemical Calculations."* Cloth. Pages xi+692. 14×20.5 cm. 1940. Silver Burdett Company, 45 East 17th Street, New York, N. Y. Price $1.84.

The organization in this third edition is similar to the organization of the earlier editions. The *New World of Chemistry* may be considered entirely new. This edition includes new and significant materials, new illustrations, and new activities.

In this edition the author has an unusual interest-arousing approach to the subject matter of chemistry. The book is written in simple, clear, and concise language. Students will find the *New World of Chemistry* fascinating, interesting, and stimulating.

A Laboratory and Workbook Units in Chemistry by Ames and Jaffe may be used with the textbook.

E. G. M.

THINGS A BOY CAN DO WITH ELECTROCHEMISTRY, by Alfred Morgan. Cloth. Pages xiii+198. 13×19.5 cm. 1940. D. Appleton-Century Company, 35 W. 32nd Street, New York, N. Y. Price $2.00.

This is a fascinating and instructive book. The author gives an interesting history of electrochemistry from its beginning to its present important place in modern chemistry. This book includes many interesting experiments which boys can perform. The author writes in simple language that is understandable to the young experimenter.

Contents of the book: New Tools for the Chemist; Niagara, the First Center of Electrochemical Industries; Some Electrochemical Processes and Product; Some Product of the Electric Furnace; Things You Should Know about Chemistry; Ions, Traveling Atoms, or Groups of Atoms; Electricity from Chemicals; An Interesting List of Metals; Experiments with Electrolysis; Storage Cells; An Electrolytic Rectifier; Miscellaneous Electrochemical Experiment.

This is an excellent reference book for students taking physical science.

E. G. M.

TRENCH MOUTH GERMS SEEN WITH ELECTRON MICROSCOPE

The germs which are believed to cause trench mouth, so-named because it was a serious ailment of soldiers in World War I trenches, have now been examined under the electron microscope, which uses particles of negative electricity to peer into secret places of matter that cannot be seen with microscopes using light and optical lenses.

Pictures of these and of the syphilis germ and other germs were shown by Dr. Katherine A. Polevitzky, Dr. Thomas F. Anderson and Dr. Harry E. Morton, of the University of Pennsylvania and RCA Manufacturing Company.

Tiny hairs, heretofore seen only with difficulty, were clearly visible at the ends of thin, spiral germs from human mouths.

The syphilis germ was found to be frequently surrounded by a slime sheath which occasionally formed thin tendrils projecting from the organism.